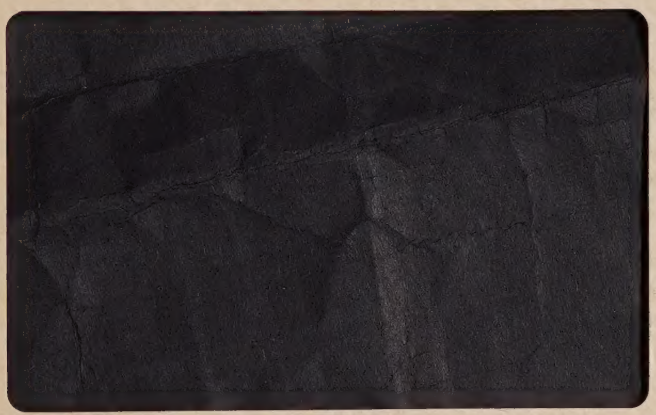
Pulse Instruments



OPERATING MANUAL

4000 SERIES
LOW NOISE FOCAL PLANE ARRAY
TEST SYSTEM

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1.0 WARRANTY AND SAFETY INFORMATION

1.1 WARRANTY

Pulse Instruments warrants these products to be free from defects in material and workmanship for a period of one year from date of shipment.

During the warranty period, Pulse Instruments will, at it`s discretion, repair or replace any products or materials returned, freight prepaid, which prove to be defective through normal use.

This warranty does not apply to defects resulting from unauthorized modification, misuse, or neglect. This warranty is in lieu of all other warranties expressed or implied, and Pulse Instruments shall not be liable for any consequential damages resulting from the use of this product.

Pulse Instruments will also not warrant the specifications as listed in this manual if other than Pulse Instruments supplied power supplies are used with this system.

1.2 SAFETY INFORMATION

1.2.1 General

1. The 4001 Control mainframe and the PI-4003 Power Mainframe use a detachable 3-wire power cord for connection to both the power source and to earth ground. These units are to be connected only to a power source outlet that has provision for properly grounding the plug.

2. Do not operate units with covers removed.

3. Service on these instruments should only be performed by authorized Pulse Instruments personnel. Unless permission to service is granted by Pulse Instruments, any service performed on these instruments could void all warranty claims.

1.2.2 Fuses

The PI-4001, PI-4003, and PI-4004 use quick-acting (normal blowing) fuses designed for general circuit protection. The three fuses are located on the front right-hand side of the mother board in both the PI-4001 Control Mainframe, the PI-4004 Power Mainframe, the PI-4003 Power Mainframe, and the PI-4002 Instrument Mainframe. Be certain that input power is disconnected before checking or replacing the fuses.

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3.0 SPECIFICATIONS

3.1 PI-4001 CONTROL MAINFRAME

CPU: ..... Intel 80186 Microprocessor.
Compatibility: .... IEEE-488 GPIB, RS-232-C.
Display: ..... 7 inch amber CRT, 80 characters per line.
Power: ..... 110 Vac ± 10%, 5 Amps max. 47/63 Hz.
220 Vac ± 10%, 2.5 Amps max. 47/63 Hz.
Dimensions: ..... 7.0" H x 17.5" W x 19.625" D.
Weight: ..... 15 lbs.
Temperature: ..... 0°C to 50°C.

3.2 PI-4002 INSTRUMENT MAINFRAME

PC Card Slots: .... Eight.
DC Input: ..... +31 Vdc, -31 Vdc, +10 Vdc, -10 Vdc.
Dimensions: ..... 7.0" H x 17.5" W x 19.625" D.
Weight: ..... 15 lbs.
Temperature: ..... 0°C to 50°C.
I/V Sense Output: Dual BNC Port isolated from chassis ground.

3.3 40460 DUAL CHANNEL DRIVER CARD

OUTPUT HIGH LEVEL: ..... +20.47 V to -19.48 V into 1 MΩ manually selectable or programmable.

RESOLUTION: ..... 10 mV or 11 bits, plus sign bit (into 1 MΩ).

ACCURACY: 100 mV of selected value for positive going transition time set to min. and may increase to 125 mV maximum for transition times > minimum value (into 1 MΩ).

OUTPUT LOW LEVEL: ..... -20.47 V to +19.47 V into 1 MΩ manually selectable or programmable.

RESOLUTION: ..... 10 mV or 11 bits, plus sign bit.

ACCURACY: 100 mV of selected value for negative going transition time set to minimum and may increase to 125 mV maximum for transition times > minimum value (into 1 MΩ).

OUTPUT AMPLITUDE: ..... 1 V TO 20 V maximum into 1 MΩ.

OUTPUT/INPUT CONNECTORS: . BNC.

RISE AND FALL TIMES (@ 20 V p-p)

40 ns - 40,000 ns in 3 Ranges.
40 ns - 400 ns 15% ± 5 ns, except tr/tf ± 40 ns.
400 ns - 4,000 ns 5% ± 20 ns.
4,000 ns - 40,000 ns 5% ± 200 ns.

OUTPUT REPETITION RATE
(3 ft. length 50 Ω cable with 100 pf load).

20 V Amplitude 8 MHz max.
15 V Amplitude 10 MHz max.

OUTPUT ABERRATIONS

5% ± 200 mV for output amplitude ≥ 3 V while driving a 3 ft. length of 50 Ω cable terminated in 100 pf//1 MΩ.

OUTPUT POLARITY:..... Normal or inverted output selected by front panel control, IEEE-488 Bus, or RS-232-C Port.

OUTPUT RESISTANCE: .. 50 Ω ± 10%.

OUTPUT NOISE: ..... 1Hz 3.5uV/√Hz, 10Hz 900nV/√Hz, 100Hz 400nV/√ Hz, 1KHz 300nV/√Hz.

CLOCK OUTPUT: .... Rear panel insulated BNC Connector, isolated from chassis ground.

TTL INPUT: ..... Rear panel insulated BNC Connector, optically isolated from clock output, and isolated from chassis ground.

CONTROL INPUTS: .. Control input optically isolated from IEEE-488 Bus and isolated from chassis ground.

CURRENT SENSE OUTPUT: . 3 Ranges: 1mA/V: 2% reading ± 3 uA.
10mA/V: 2% reading ± 30 uA.
25mA/V: 2% reading ± 300 uA.

VOLTAGE SENSE OUTPUT: . 2 Ranges: 2 V: 0.2% reading ± 4 mV.

20 V: 0.2% reading ± 40 mV.

3.4 40480 HIGH SPEED DRIVER PC CARD

Output Characteristics

Output characteristics are measured using a 4ft. length of 50 Ω Cable connecting the output to the specified load.

	1 MOhm load // 15pf	50 Ohm Load
High Level		
Range:	+20 V to -10 V	+10 V to -5V
Resolution:	10mV	5mV
Accuracy:	0.1% of prog. value ± 100mV	5% of prog. value ± 50mV
Low Level		
Range:	+10 V to -20 V	+5 V to -10 V
Resolution:	10mV	5mV
Accuracy:	0.1% of prog. value ± 100mV	5% of prog. value ± 50mV
Amplitude:	20 V to 2 V	10 V to 1 V
Rise and Fall Times:	5ns Max.	3.5ns Max.
Max. Repetition Rates:	50 MHz	60 MHz
Output Aberrations:	5% of Vo p-p +350mV for Vo p-p > 2V	5% of Vo p-p + 200mV for Vo p-p > 1V
Output Resistance:	Not Measured	50Ω ± 5% for 1V ≤ Vo p-p ≤ 10 V
Output Polarity:	Normal or Inverted	Normal or Inverted

External Source - TTL

Input Resistance:	50 Ω or 500 Ω, DC Coupled, ± 10%
Input Voltage Range:	2 V to 5 V
Minimum Pulse Width:	7ns
Maximum Clock Rate:	60 MHz

Jitter: 0.1% of programmed value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Max. Duty Cycle: Greater than 50%.

DOUBLE PULSE

Range: Spacing between pulse pair variable from 16.6ns minimum to 90ms maximum.

Resolution: 1% of Programmed Value maximum or 100ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Maximum Duty Cycle: Greater than 50%.

TRIGGER OUTPUT

Amplitude: 1 V into 50 Ω minimum.

Minimum Pulse Width: 7ns, TTL input, 25ns Optically isolated input.

Delay: 10ns maximum with respect to TTL input.
65ns maximum with respect to Optically isolated input.

OUTPUT/INPUT CONNECTORS: BNC

CLOCK OUTPUT: .... Rear panel BNC Connector.

TTL INPUT: Rear Panel BNC Connector.

OPTICALLY ISOLATED TTL INPUT: ..... Rear panel BNC Connector, optically isolated from clock output, and isolated from chassis ground.

CONTROL INPUTS: .. Control input optically isolated from IEEE-488 Bus and isolated from chassis ground.

CURRENT SENSE OUTPUT: Not Available.

VOLTAGE SENSE OUTPUT: . 2 Ranges: 20 V: 0.2% reading ± 4 mV.
200 V: 0.2% reading ± 40 mV.

External Source - Optically Isolated

Input Impedance: 300 Ω in series with LED

Input Voltage Range: 3V to 6V (3mA to 10mA max)

Minimum Pulse Width: 25ns

Max Clock Rate: 20 MHz.

MODES OF OPERATION

EXT WIDTH, INT WIDTH, INT DELAY/WIDTH AND DOUBLE PULSE

All timing parameters are measured, using the External TTL input with 50 Ohm input impedance and with the output terminated into 50 Ohms.

EXT WIDTH

Output pulse width or pattern controlled by pulse width or pattern of external signal. 8ns minimum output pulse width and 12ns maximum output delay with respect to trigger output.

INT WIDTH

Range: Output pulse width variable from 8ns to 90ms maximum.

Resolution: 1% of Programmed Value maximum or 100ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

Jitter: 0.1% of programmed value + 100ps.

Offset Delay: Fixed 21ns ± 3ns with respect to trigger output.

Max. Duty Cycle: Greater than 50%.

INT DELAY/WIDTH

Range: Output delay with respect to trigger output variable from 30ns minimum to 90ms maximum.
Output Pulse Width characteristics identical to those under INT WIDTH

Resolution: 1% of Programmed Value maximum or 200ps, whichever is greater.

Accuracy: 5% of programmed value ± 2ns

3.5 40740 FOUR CHANNEL, BIPOLAR DC BIAS SUPPLY CARD

OUTPUT VOLTAGE:..... +20.47 V, to -20.48 V selectable from front panel control or programmable via IEEE-488 Bus.

RESOLUTION: 10 mV or 11 bits, plus sign bit.

High resolution mode provides 1 mV or 0.5 mV resolution when 2 channels are combined.

ACCURACY: ..... ± 20 mV of selected value (into 1 M Ω).

OUTPUT CURRENT:... ± 25 ma max. for -20V ≤ Vo ≤ +20V.

OUTPUT RESISTANCE: 75 milli-Ohms max. for Io ≤ +25 mA.

OUTPUT NOISE:.... 1Hz 850nV/√Hz, 10Hz 300nV/√Hz, 100Hz 200nV/√Hz, 1kHz 100nV/√Hz, 10kHz 50nV/√Hz.

CURRENT SENSE: .. 1 mA/V: 0.2% reading ± 1 uA.
10 mA/V: 0.2% reading ± 10 uA.
100 mA/V:0.2% reading ± 100 uA.

VOLTAGE SENSE: 2 V: 0.2% reading ± 0.5 mV.
20 V:0.2% reading ± 5 mV.

3.6 40750 FOUR CHANNEL, BIPOLAR LOW NOISE DC BIAS SUPPLY CARD

OUTPUT VOLTAGE:..... Range 1 -10.24 V to +10.235 V.
Range 2 -20.48 V to +20.47 V.
Selectable from front panel control or programmable via IEEE-488 Bus.

RESOLUTION: 11 bits plus sign bit. or Range 1, 5 mV.
Range 2, 10 mV.

High Resolution Mode provides 0.5 mV or 0.250 mV resolution when 2 channels are combined.

ACCURACY: ..... ± 20 mV of selected value (into 1 MΩ).

OUTPUT CURRENT:.. ± 25 ma max. for -20 V ≤ Vo ≤ +20 V.

OUTPUT RESISTANCE: 75 milli-Ohms max. for Io ≤ +25 mA.

OUTPUT NOISE:.....	Range 1	Range 2
1 Hz	250 nV/√Hz	350 nV/√Hz
10 Hz	75 nV/√Hz	100 nV/√Hz
100 Hz	75 nV/√Hz	75 nV/√Hz
1 KHz	50 nV/√Hz	50 nV/√Hz
10 KHz	50 nV/√Hz	50 nV/√Hz

CURRENT SENSE: .. 1 mA/V: 0.2% reading ± 1 uA.
10 mA/V: 0.2% reading ± 10 uA.
100 mA/V: 0.25% reading ± 100 uA.

VOLTAGE SENSE: 2V: 0.2% reading ± 0.5 mV.
20V: 0.2% reading ± 5 mV.

3.7 PI-4003 DC POWER MAINFRAME

1- +31VDC 10 AMPS
1- -31VDC 10 AMPS
1- +10VDC 10 AMPS
1- -10 VDC 10 AMPS

Load Regulation: ± 0.1% (0 to 100% full load).
Line Regulation: 0.2% (20% line change).
Noise and Ripple: 0.1% peak to peak.
Transient Response: less than 50 μsec for 50% load change.
Temperature Coefficient: ± 0.01%/°C maximum.
Stability: ± 0.1% maximum for 24 hours after warm-up.

3.8 PI-4004 DC POWER MAINFRAME

1- +31VDC 5 AMPS
1- -31VDC 5 AMPS
1- +10VDC 5 AMPS
1- -10vdc 5 AMPS

Load Regulation: ± 0.1% (0 to 100% full load).
Line Regulation: 0.2% (20% line change).
Noise and Ripple: 0.1% peak to peak.
Transient Response: less than 50 usec for 50% load change.
Temperature Coefficient: ± 0.01%/°C maximum.
Stability: ± 0.1% maximum for 24 hours after warm-up.

---

1. Unless otherwise specified, all dynamic measurements are made using a 3 ft. length, 50 Ω coaxial cable transmitted into 15pf/1MΩ (such as the input of a 300MHz oscilloscope).

4.0 INSTALLATION

4.1 INTRODUCTION

This operating manual contains all the information required to install, operate and program the PI-4001/4002/4003/4004 mainframes, and all options and accessories.

The PI-4000 Series Test System is a complex instrument that is capable of performing many tasks. To use this instrument to full advantage, a thorough reading of this manual is required.

4.2 PACKING AND UNPACKING

The PI-4001/4002 Mainframes were shipped to you in a foam filled carton that was designed to withstand normal shipping requirements. Please report any damages to the carrier as soon as possible.

The PI-4001 Control Mainframe was shipped with the following accessories:

1 - Operators Manual
1 - Power Cord
1 - 40090-X PI-Bus Interconnect cable
1 - Set Rack Slides (If unit is Rack Mount Version)

Please contact Pulse Instruments immediately if you find any discrepancies.

***** DO NOT TURN THE POWER ON UNTIL *****
***** YOU HAVE READ THE FOLLOWING: *****

4.3 POWER REQUIREMENTS

The Pulse Instruments Model PI-4001 Control Mainframe and the PI-4003/4004 DC Power Mainframe are designed to operate from either a 120V or 220V power source, depending upon the model shipped from the factory. The label in the bottom rear corner of the back panel above the power receptacle indicates the voltage inputs required for operation of your units.

Please verify that the voltage indicated is correct for your intended application before connecting power cords to the units, or the units to the power source.

4.4 COOLING AND VENTILATION

To prevent damage or over-heating to your PI-4001/4002/4003/4004, please make certain that there are no obstructions near the unit that would tend to defeat the operation of the rear fans or the air flow vents located around the unit. Adequate circulation and ventilation are necessary for proper unit operation and instrument life. It is recommended that a space of 1.75 Inches be used between each mainframe for proper ventilation.

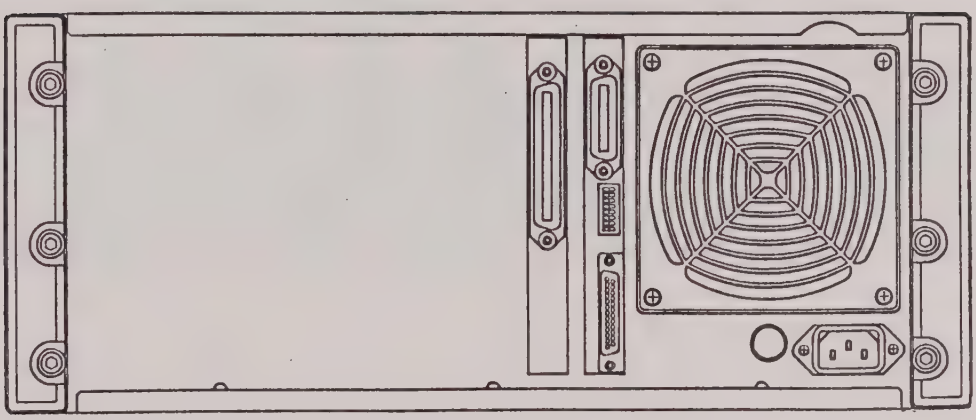
4.5 CONFIGURATION

The PI-4001/4002/4003/4004 is normally supplied in rack mount configuration. If you intend to use the unit for bench top applications only, the factory should be notified at the time of ordering, as removal of the rack mount slide brackets require operations from inside the unit.

All printed circuit boards that are supplied as part of your unit were installed at the factory. You may, however, re-arrange the Driver and Bias supply cards to any configuration that you require within the eight output card slots. Resetting the system will bring up the new PC Card configuration.

You can also get the configuration of your system over the IEEE-488 Bus or through the RS-232-C Port with the ID Command. See Section 9.0 Programming the 4000 Series System.

4.6 REAR PANEL -- PI-4001 Control Mainframe



4.6.1 General

The PI-4001 Control Mainframe is programmable through compatibility with the IEEE-488 GPIB and EIA STD. RS-232-C for Full Duplex Asynchronous Receiver/ Transmitter operation.

These connectors are located in the control slot labeled B on the right rear of the mainframe. The DIP-Switch between the two connectors is used for setting the IEEE-488 address.

The second or left control slot contains the connector for the PI-Bus. The ribbon cable that is connected to the PI-Bus connector has been designed to daisy chain all of the PI-4002 Instrument Mainframes in the system to the PI-Bus connection at the rear of the PI-4001 Control Mainframe. This Bus is optically isolated between the control mainframe and the instrument mainframe to prevent transfer of the digital noise in the PI-4001 Control Mainframe to the Instrument Mainframes. The PI-Bus cable is connected to control slot A on the PI-4002 Instrument Mainframes.

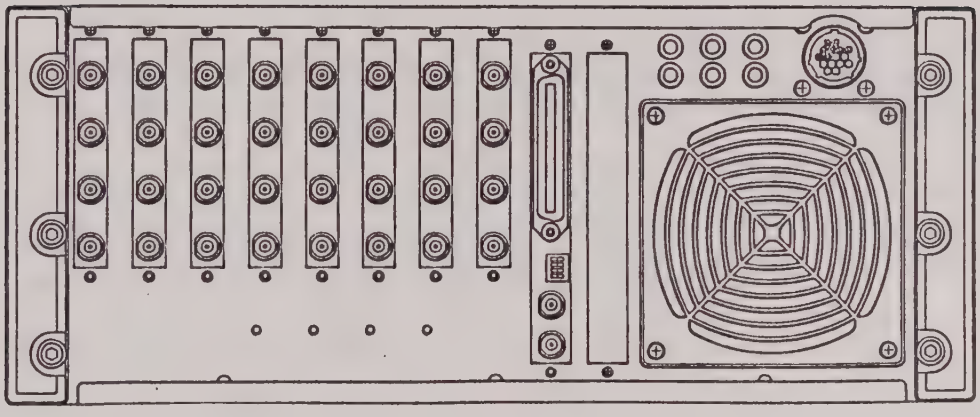
The PI-4001 Control Mainframes have their own internal power supplies and should be connected to your AC power source.

The PI-4002 Instrument Mainframes are to be connected to DC Power Supplies (PI-4003 or PI-4004) through the power connector on the top right rear corner of each PI-4002 Instrument Mainframe.

4.6.2 Remote Operation of PI-4002 Instrument Mainframe.

The PI-4002 Instrument Mainframe can be placed a maximum of 23 feet from the PI-4001 Control Mainframe. This distance takes into consideration the absolute distance of the length of 40090-X daisy chain cable from the connector mount on the rear of the PI-4001 to the cable connection on the rear of the farthest distance cable connection on the PI-4002 Instrument Mainframe, if there are more than one PI-4002 Instrument Mainframe in the system.

4.7 REAR PANEL -- PI-4002 Instrument Mainframe



4.7.1 General

The following information is a description of the connections to be made on the rear of the PI-4002 Instrument Mainframe. The internal motherboard is floating with respect to the case.

The Instrument Mainframe can be placed in a remote location with respect to the PI-4001 Control Mainframe. See Section 4.6.2

1. The A Control Slot is used for the ribbon connector from the A control slot of the PI-4001 Control Mainframe. This ribbon cable contains the PI-Bus. It is connected in daisy chain fashion to the PI-4002 Instrument Mainframes. The connectors are keyed, and can only be installed in one way. Using a small screwdriver or similar tool, carefully press the wire lock on the top of the connector in place to prevent the cable from working loose if the cable is moved or stressed.

2. The slots that are labeled from 1 to 8 are for the driver and bias PC cards. These cards can be installed into any slot and mixed throughout the mainframe. If you intend to re-arrange the cards, turn off power to the system. If you re-arrange the cards, you will have to change any software that has been created, to reference the new slot locations.

3. The DIP-Switch directly below the PI-Bus connector in the A control slot is used for setting the Instrument Mainframe Number. Each mainframe used in the system must be set to a different mainframe number to allow access to the mainframe by the PI-4001 Control Mainframe. The mainframe numbers can be from one to seven. There can be as many as four mainframes controlled from one PI-4001 Control Mainfame.

You will note the Instrument Mainframe numbers on the Location section of the menu headings on the Main Menu. The DIP-Switch is ON, to the right side. The numbers are added in the ON position.

4. The six banana jacks in the upper right corner are the Voltage monitor jacks. These jacks are used for monitoring the system DC voltage that is connected to the DC power connector. These Jacks are not for connection to any other source and are not to be used to draw power from the mainframe.

The outputs from these jacks are as listed:

--- White ... -31 Vdc
--- Blue .... +10 Vdc
--- Red ..... +31 Vdc
--- Black ... Ground
--- Green ... Case
--- Yellow .. -10 Vdc

The internal motherboard and the PC Cards are floating with respect to the case. You may ground the motherboard and PC Cards by connecting a jumper between the Black and Green banana jacks.

HOWEVER, YOU WILL INCREASE SYSTEM NOISE IF THIS IS DONE.

The system DC Voltages should be set using the ADJ pots on the front of the PI-4003/4004 Power Supply to the following tolerances:

-31 Vdc: In range from -31 Vdc to -33 Vdc.
+31 Vdc: In range from +31 Vdc to +33 Vdc.
+10 Vdc: In range from +9 Vdc to +11 Vdc.
-10 Vdc: In range from -9 Vdc to -11 Vdc

These measurements should be made from the Voltage monitor banana jacks with respect to the black Voltage monitor banana jack, which is power supply ground.

5. The PI-4002 Instrument Mainframes are to be connected to DC Power Supplies through the power connector on the top right rear corner of each PI-4002 Instrument Mainframe, by using the 40093 DC Power Cables. The connectors are keyed and can only be inserted one way. The opposite end of the connector is connected to any of the rear connectors, labeled J1 through J4, on the rear of the PI-4003/4004 DC Power Mainframe. If you are not using the PI-4003 DC Power Mainframe, refer to the pin basing diagram for the DC Power connectors in this section.

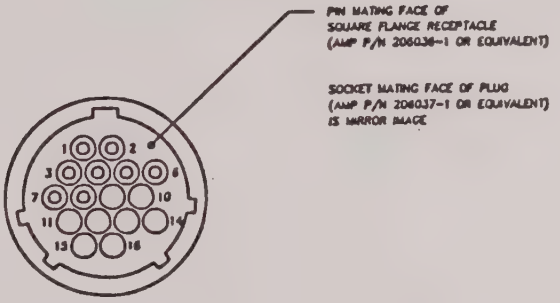
6. The two BNC Connectors directly below the DIP-Switch in control slot A are the sense connectors. The top BNC connector is the "+" or Positive output, and the lower BNC connector is the "-" or Negative output. These outputs are used as the DVM connection for the current and Voltage sense functions of the Driver and DC Bias PC Cards. There is a polarity shift between Voltage and current measurements on these pins. See Section 8.2.2 for more information regarding this feature.

In systems using more than one PI-4002 Instrument Mainframe, the Sense connectors should be tied together in parallel to allow "muxing" of more than one mainframe into one DVM. The Sense connectors allow use of the Sense function in the same manner as a Scanner; manually, or over the IEEE-488 Bus or RS-232-C Port. The sense connectors on the individual PI-4002 Instrument Mainframes must be connected together in parallel, or Tee'd to allow the muxing feature to operate.

Please note that the outer case of the PI-4002 is floating with respect to the internal motherboard, which allows the PC Cards to float with respect to the case. If you require the internal PC Cards to be at the same ground potential as the case, a connection can be made between the green and black banana plugs on the rear of the PI-4002 mainframe. This connection will severely increase the system noise.

The Following diagram illustrates the power supply connector wiring on the rear of the PI-4002 Instrument Mainframe.

PIN INSTALLATION TABLE	
PIN NO.	
1	+31 V
2	GND RETURN
3	-31 V
4	GND RETURN
5	+10 V
6	GND RETURN
7	-10 V
8	GND RETURN
9	NO PIN
10	NO PIN
11	NO PIN
12	NO PIN
13	NO PIN
14	NO PIN
15	NO PIN
16	NO PIN



PI-4002 Instrument Mainframe Power Connector Basing -- Rear View

Once the Power Supplies have been connected to the PI-4002 Instrument Mainframes, and the interconnects have been made using the PI-Bus Interconnect Cable, power can be applied to the system.

The power-up sequence is as follows:

1. Turn on the DC Power Supplies, or the PI-4003/4004 DC Power Mainframe.

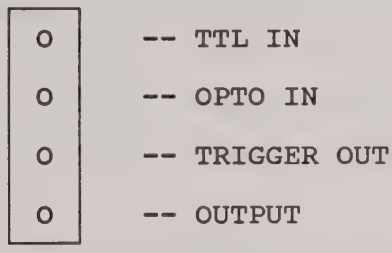
2. Turn on the front panel switch on the PI-4002 Instrument Mainframe.

3. Turn on the PI-4001 Control Mainframe.

If the System is not powered up in this sequence, the CRT will display a reset condition, since the PI-4001 will search for the PC Cards, and will not find them, if the PI-4002 is not turned on.

4.7.2 Connectors on 40480 50MHZ Driver PC Card

The BNC connectors on the rear of the 40480 Driver PC Card are as follows:



TTL IN -- Direct input to the PC Card. Not optically isolated, will allow 50 MHz. Output.

OPTO IN -- Optically isolated input. Will allow maximum 20 MHz output frequency.

TRIGGER OUT -- Trigger supplied for use with oscilloscope or other functions. Also the reference for Internal Width and Delay functions.

OUTPUT -- Output of the Driver PC Card.

5.0 BASIC DESCRIPTION

5.1 General

The 4000 Series Low Noise Test System represents an entirely new approach to the instrumentation manufactured by Pulse Instruments for the testing of Focal Plane Arrays and Charge Coupled Devices.

The system uses a mainframe approach that separates the digital electronics from the bias and drive circuitry, both optically and through the use of separate power sources. This feature provides a very high level of noise immunity.

The power required for the Driver PC Cards and DC Bias Supply PC Cards, located in the PI-4002 Instrument Mainframe is supplied by separate power supplies (the PI-4003) that are located physically in the rack, but are not part of the PI-4002 Instrument Mainframes. There is also circuitry within the PI-4002 Instrument Mainframe to detect any loss of input power to the mainframe, and to reset the outputs of the drivers and biases to 0 Volts in the event of loss of power. This feature provides maximum protection to the device under test in case of power failure or loss of any supply input.

The PI-4003 Power Mainframe and the PI-4002 Instrument Mainframes are floating to insure the least possible noise from the power system. The separate mainframe structure will also allow the drivers and bias supplies to be located in close proximity to the device under test, if desired, while the digital electronics can be located in a remote area. There is also protection against transients that could possibly damage the Device Under Test. When the power is turned on or off, the output voltage levels on all drivers and bias supplies are held to the range of ± 3 Volts.

The system will require at least one PI-4001 Control Mainframe, and one PI-4002 Instrument Mainframe, and a source of DC power, such as the PI-4003 Power Mainframe for the PI-4002 Instrument Mainframe.

The PI-4001 Control Mainframe is microprocessor controlled, and contains all the digital circuitry for controlling the drivers, bias supplies, and all other system functions, via an optically isolated bi-directional bus connected to the PI-4002 Instrument Mainframes.

The PI-4001 contains it's own source of power to allow complete isolation of the PI-4002 Instrument Mainframes from general digital noise and noise created over the IEEE-488 Bus or RS-232-C Serial Port. The Control Mainframe has the capability to select up to four PI-4002 Instrument Mainframes and the Driver and Bias Supply PC Cards associated with these mainframes.

The PI-4002 Instrument Mainframe is configured to accept eight plug-in PC Cards. This will allow up to 16 channels of dual channel driver output, or up to 32 channels of bias supply output in a single mainframe. The driver cards and bias supply cards can also be mixed in the instrument mainframe in any desired combination.

The system shares a common bus structure in all models of mainframes. This allows flexibility in design and the addition of future modules and options, without the need to re-design the entire package.

5.1.1 40460 Dual Channel Driver PC Cards.

The 40460 Driver PC Card consists of two channels of 10MHz. drivers. The output Voltage capability is ± 20V., and the input from the Data Generator is optically isolated. The PC Card also contains the circuitry for the programmable rise and fall time, and Voltage and Current Sense.

5.1.2 40740 Four Channel, Bipolar DC Bias Supply PC Cards

The 40740 Four Channel DC Bias cards each contain four channels of ± 20V DC bias outputs. The bias supplies contain Voltage and Current Sense, and are floating with respect to the PI-4001 Control Mainframe.

5.1.3 40461 High Voltage Dual Channel Driver PC Cards.

The 40461 Driver PC Card consists of two channels of 8MHz. drivers. The output Voltage capability is ± 25V., and the input from the Data Generator is optically isolated. The PC Card also contains the circuitry for the programmable rise and fall time, and Voltage and Current Sense. This PC Card cannot be used with the existing Power Mainframe, and Power Supplies capable of supplying ± 36 Vdc must be used.

5.1.4 40741 High Voltage Four Channel, Bipolar DC Bias Supply PC Cards

The 40741 Four Channel DC Bias cards each contain four channels of ± 25 DC bias outputs. The bias supplies contain Voltage

and Current Sense, and are floating with respect to the PI-4001 Control Mainframe. This PC Card cannot be used with the existing Power Mainframe, and Power Supplies capable of supplying ± 36 Vdc must be used.

Please note that the 40461 and 40741 PC Cards cannot be used with the PI-4003/4004 Power Supplies due to the higher Voltage requirements needed from the system power supplies. Consult the factory for details on the power requirements for these PC Cards.

The PI-4003 DC Power Mainframe can supply power for 3 PI-4002 Instrument Mainframes.

The PI-4004 DC Power Mainframe can supply power for 2 PI-4002 Instrument Mainframes.

6.0 CONFIGURATION INFORMATION AND OPTIONS-4000 SERIES LOW NOISE TEST SYSTEM

PI-4001 Control Mainframe...Contains all intelligent control for the system, and the front panel control for manual use.

PI-4002 Instrument Mainframe...Contains eight slots for installation of PC Cards as required for the system, and receives all information from PI-4001 Control Mainframe.

PI-4003 DC Power Mainframe...Supplies DC power for up to 3 PI-4002 Instrument Mainframes.

PI-4004 DC Power Mainframe...Supplies DC power for up to 2 PI-4002 Instrument Mainframes.

40460 Dual Channel Clock Driver PC Card... Contains two channels of ± 20 V., 8MHz. Clock Drivers.

40740 Four channel Bias Supply PC Card...Contains four channels of ± 20 V., 25ma. DC Bias Supplies.

40461 Dual Channel Clock Driver PC Card... Contains two channels of ± 25 V., 8MHz. Clock Drivers.

40741 Four channel Bias Supply PC Card...Contains four channels of ± 25 V., 25ma. DC Bias Supplies.

40480 50 MHz. Clock Driver PC Card...Contains one channel of ± 20 V., 50 MHz. Clock Driver.

40750 Low Noise Four Channel Bias Supply PC Card...Contains four channels of ± 20 V., 25mA DC Bias Supplies with 250 nV/ Hz Output Noise Levels at 1 Hz.

7.0 FRONT PANEL CONTROLS

7.1 General

> NOTE: WORDS WHICH ARE BRACKETED REPRESENT FRONT PANEL KEYS, EG. THE THE PREV KEY IS REPRESENTED BY [PREV].

7.1.1 Power On/Off Switch.....Applies power to the PI-4001 Control Mainframe. Turning off power will remove all contents of the Volatile memory, which will include all present instrument settings.

7.1.2 Cursor Controls.....Allows movement of the cursor up, down, left, or right. Cursor movement on each menu is based on individual menu requirements.

7.1.3 [Home] Key.....Places the cursor on Channel one of the Main Menu. This key is also used to remove the window display from the CRT when the [ZOOM] Softkey is pressed. The [Home] Key when pressed at the same time as the [CE] Key comprises the system reset. The system reset sets all bias and driver output voltages to 0 volts, and places the system in the Off Line Mode.

7.1.4 [PREV] Key.....Allows selection of the last menu or previous display in the menu sequence, or when the [ZOOM] Softkey is pressed, will allow select of the previous PC Card to be windowed on the CRT.

7.1.5 [NEXT] Key.....Allows selection of the next menu in sequence, or when the [ZOOM] Softkey is pressed, will allow the selection of the next PC Card to be windowed on the CRT.

7.2 FUNCTION KEYS

7.2.1 General

The references to the function keys below will describe their use in this system.

7.2.2 [UPDATE] Key -- Not in use, since the software is now automatically updated.

7.2.3 [LINE] Key -- The [LINE] Key is used to set the Off Line and On Line status of the system. When the system is first turned on, immediately upon power up, the default setting of the outputs is 0 Volts, and the unit is in the Off Line state.

In the Off Line state, any changes to any driver or bias output Voltages will not be reflected in the output until the unit is placed in the On Line state by toggling the [LINE] Key. The top of the CRT display provides an indication of the current setting of this function.

The On Line, Off Line Feature is designed to protect the device under test during set up and editing of the output levels.

NOTE: If you are in the On Line state and go to Off Line, the output voltages remain the same as they were before you went off line. If you should change the voltage levels while you are in the Off Line State, going back On Line would now give you the new output levels.

7.2.4 [Lock] Key -- The [Lock] Key is presently being used for the Connect/Disconnect feature. When pressed, this key places the outputs through a small resistance to ground to effectively disconnect the outputs of the system. When in the disconnected mode, the screen display will display disconnect at the Online/Offline location. Pressing this key again will bring the instrument back to the Offline state. Pressing the [Offline] Key will bring the system back to Online.

7.3 SOFTKEYS

7.3.1 General

The function and value of the 6 softkeys are software defined. Since each successive menu redefines their use, the softkeys represent approximately 24 different functions. Their location directly below the CRT allows easy coordination with their current value or function, which is displayed on the lower portion of the CRT. Please refer to the menu section for the value and function descriptions of the individual keys.

7.4 DATA KEYS

7.4.1 Data Keys

The data keys enable new parameter values and output data to be entered. The PI-4001 Control Mainframe will accept decimal, binary, or hexadecimal data entry as required by the function being set.

7.4.2 Clear Entry [CE]

The [CE] key will clear out any information that has been entered by the data keys prior to pressing [ENT]

7.4.3 Enter [ENT]

The [ENT] key assembles all new parameter values and performs the entry of these values into program operation.

8.0 SYSTEM MENUS

8.1 NON VOLATILE STORAGE MENU - 90040 NON-VOLATILE MEMORY OPTION

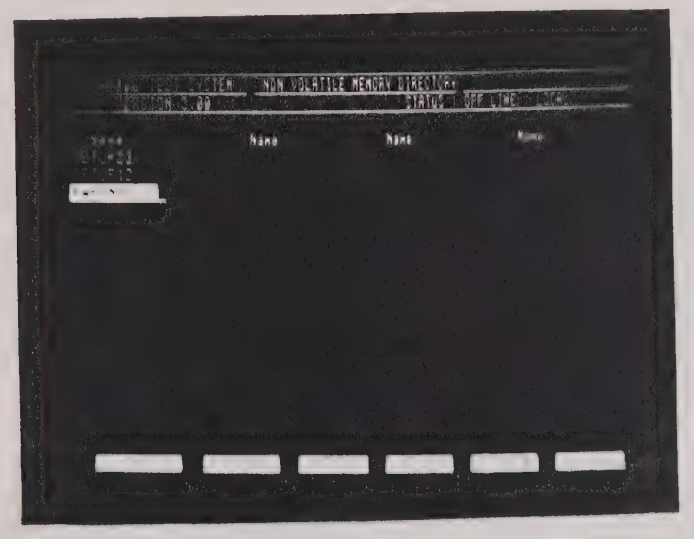


Figure 7. Directory Non-Volatile Memory Option

8.1.1 General

If the 90040 Non-Volatile Memory Option is installed in your PI-4001, You will see the Non Volatile Memory Directory on Power up. If you do not see this Menu, then the option is not installed.

The information shown on the display provides you with the type of file, and the user assigned reference number, for all of the files in non-volatile memory.

The 90040 Non-Volatile Memory Option allows the user to store up to 256K Bytes of instrument set-up within the PI-4001 Control Mainframe for later recall. All functions are available over the IEEE-488 Bus or through the RS-232-C Port, or from the front panel.

64 programs or files can be stored, or up to 256K Bytes of information. The files stored contain the Voltage settings of each channel of Driver and DC Bias PC Card, and also the pre-set maximum Voltage limits that are user settable for each channel of Driver and DC Bias. The following information will assume that you are familiar with operation and set-up of the 4000 System as described in this Manual.

The devices being used for non volatile storage are battery powered RAMS, which were selected for their fast access times. The RAMS are powered by Lithium batteries that have an expected use life of 10 years.

Each file saved is assigned a reference number by the user. These numbers can be from 1 to 4095. You cannot use the same number for a similar type of file, but the same number can be assigned to files of a different type. The following files can be saved.

1. SETUP -- Selecting this option will let you save the entire setup currently in the instrument. A file built under the SETUP command is a file that contains all of the function settings that were established within the instrument at the time the file was saved, as well as the maximum Voltage limits for each channel of Driver and DC Bias channel in the system. A typical directory entry for a setup would be:

SETUP3

Where: SETUP refers to saving all of the program.
3 is the number assigned by the user to identify the program.

2. PWRON -- This file is identical to the files built under set up, except that this is the power up file. One file can be designated as the file that will automatically be loaded upon power up. The file loads automatically, and applies the Voltage limits to the Drivers and DC Bias PC Cards that were previously set on the Bias Cards and Driver Cards Limits Setting Menus.

8.1.2 Explanation of Softkeys - Non Volatile Storage

The softkeys are defined as follows:

[SAVE] [LOAD] [DELETE] [PWRONDEF] [PWRONFIL] [SETLIMIT]

[SAVE] - When a program has been established, and is ready to be saved, pressing the [SAVE] softkey will begin the sequence of events to allow the save of the set up currently in memory.

Once you have pressed the [SAVE] softkey, you are given the message, "Save as File Number:". Enter the identifying number from 1 to 4095 that you select, and press [ENT]. The Message, "file Saved", will appear.

If a file has already been created using the number you have selected, you will be presented with the following options and message, "Overwrite? Confirm (ENT/NEXT = Yes, CE/PREV = No) ?".

Pressing [ENT] or [Next] will destroy the old file and Write the new file in it's place. Pressing [CE] or [PREV] will take you out of the function and allow you to choose a new identifying number for the file to be saved.

[LOAD] - Allows the loading of programs that are internally stored. Pressing the [LOAD] softkey will begin the sequence of events that will allow loading and use of the selected internally stored program.

[DELETE] - Programs to be deleted are selected with the Up/Down Cursor controls. IF YOU SELECT A FILE AND PERFORM THE [DELETE] FUNCTION, THERE IS A PERMANENT LOSS OF THIS FILE.

To delete a file, select the file with the Cursor. The message, "Delete File? Confirm (ENT/NEXT = yes, CE/PREV = no)?", will be displayed.

Pressing [ENT] or [NEXT] will destroy the file. Pressing [CE] or [PREV] will take you out of the function without deleting the file.

[PWRONDEF] - Sets the system with all Driver, Bias channels at 0 V output and all programmable Limits for the drivers and biases as established on the Driver/Bias Limits Setting Menu set for maximum output Voltage (-20.48 to +20.47).

Since the system will power up with the program that is set with the [PWRONFIL] softkey, to power up the system in the all 0V output mode, press the [PWRONDEF] softkey to set the instrument to default condition. Then press the [SAVE] softkey and enter the file number when asked, to save the default condition. Now place the cursor on the file that you just saved, and press the [PWRONDEF] softkey to make the default condition the power up file.

[PWRONFIL] - Pressing this softkey places the file at the location of the cursor as the file that is automatically loaded at power up. The Power on file can be changed at any time by selecting another file and pressing the [PWRONFIL] softkey twice; once to remove the present power up file as the default, and once to select the file at the location of the cursor as the power up file.

8.2 MAIN MENU

```
                4000 SERIES FPA TEST SYSTEM          MAIN MENU

 VERSION 3.12                                STATUS: OFFLINE : LOCAL

No LABEL LOC.      TYPE     VOLT/HLV     LLV      STEP TR TF SENSE
 1       1-4-1     DRIVER    0.0000    -10.0000   10 20 20    20V
 2       1-4-2     DRIVER   10.0000      0.0000   20 40 40    20V
 3       1-5-1     LNBIAS   10.0000               50          20v
 4       1-5-2     LNBIAS   10.0000               80
 5       1-5-3     LNBIAS   10.0000               50
 6       1-5-4     LNBIAS   10.0000               60
 7
 8
 9
10
11
12
13
14
15
16

   [GO TO]     [EDIT]    [INCR]     [DECR]    [SET ALL]     [ZOOM]
```

8.2.1 General

The Main Menu provides you with a data base style listing of all of the PC Cards that are currently in the system. The PC cards are presented in the order that they are installed in the system, beginning with the lowest mainframe number.

The Main Menu is also the default power up menu, if the system does not have the Non-Volatile Memory Option.

If you prefer the Bias and Driver PC Cards separated as to type, this can be accomplished by:

1. Install the PC Cards in the system as you would like them displayed.

2. Edit the PC Cards as displayed through the use of the [EDIT] Softkey.

3. Edit the display and save the set up in Non-Volatile Memory as the Power-on default file, or as a file that can be called.

All references to row in this manual refer to the horizontal data across the CRT that is referring to a particular CHANNEL of output.

All references to column refer to a particular FUNCTION displayed vertically down the display which affects all channels.

The Main Menu is used for setting all PC Card parameters, either as displayed on the Menu, or through use of the [ZOOM] Softkey to gain access to additional parameters not on the Main Menu display.

To set the Voltage output on a selected channel, using the cursor keys, place the cursor on the channel you want to set and enter the voltage with the data keys, pressing the [ENT] Key will set the Voltage into the channel.

To RESET the system, simultaneously press the [HOME] and the [CE] Keys. Resetting the system will destroy the contents of volatile memory and place the system in the same condition as power on.

8.2.2 Main Menu Headings

The following information is a description of the Menu Headings and their functions. In many columns you will notice N.A. shown. This represents a non-applicable setting which is applied to all functions that are voltage dependent when there is a voltage setting of 0.

1. No. -- Number refers to the numbers of the PC Cards in the order that they found by the software as it polls the mainframes in order. The [GOTO] Softkey when used with this number allows you to call up any channel.

2. LABEL -- The Label indicators are blank if the four character labels have not been programmed over the IEEE-488 Bus or RS-232-C Port.

3. LOC. -- Location (Example, 3-1-2). the "3" represents the PI-4002 Instrument Mainframe number and the "1" represents the slot in that particular mainframe where the card is located. The "2" represents the particular channel on the PC Card. The mainframe number is set by the dip-switch on the rear of each mainframe. The eight slots are numbered from right to left from the rear of the mainframe.

4. TYPE -- Refers to the type of PC Card in the particular slot.

5. VOLT/HLV -- VOLT/HLV indicates the current setting of the DC Bias PC Card that is in the selected location. It also represents the high level Voltage of the total swing of the output Voltage of a Driver PC Card. The difference between the High Level Voltage and the Low Level Voltage cannot exceed 20 volts for the 40460 Driver PC Card, or 20V for the 40480 Driver PC Card. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

6. LLV (Volt) -- This represents the Low Level Voltage of the total swing of the output Voltage of a driver. The absolute difference between the High Level Voltage, and the Low Level Voltage cannot exceed 20 Volts for the 40460 Driver PC Card, or 20V for the 40480 Driver PC Card. The LLV or Low Level Voltage must always be set below or equal to the High Level Voltage.

7. STEP -- The Step refers to the present incremental setting of the PC Card selected by the cursor. The step is used for setting the current value to be incremented or decremented when setting High Level Voltage, The Low Level Voltage, and the Voltage output of the DC Biases. The values of the step function can be from 10mV to 100mV in 10mV increments.

8. TR (ns) -- The programmable Tr feature allows the setting of the rise and fall times of the individual channel outputs, either by front panel control, or remotely, over the IEEE-488 Bus or RS-232-C Port. Any value within range can be set at the point of the cursor with the data keys and [Ent] Key. The Rise and Fall Times are fixed on the 40480 Driver PC Card. See Section 8.2.5, Setting the programmable Rise and Fall Times.

9. TF (ns) -- The programmable TF feature allows the setting of the fall times of the individual channel outputs either by front panel control, or remotely, over the IEEE-488 Bus or RS-232-C Port. Any value within range can be set at the point of the cursor with the data keys and [Ent] Key. The Rise and Fall Times are fixed on the 40480 Driver PC Cards. See Section 8.2.5, Setting the programmable Rise and Fall Times.

10. SENSE -- The Sense column provides the Voltage or Current range status of each Driver or DC Bias output when the channel Voltage or Current Sense has been set. Current Sense is not available on the 40480 Driver PC Card. The selection of either Voltage or Current Sense can be made by placing the cursor in the Sense column of the desired PC Card and pressing the [INC] or [DEC] Softkey to toggle the available settings. This feature can also be set in the Zoom Mode.

8.2.3 Explanation of Softkeys

The First Page of softkeys Main Menu are as follows:

[GOTO] [EDIT] [INC] [DEC] [SET ALL] [ZOOM]

[GOTO] -- Allows access to any channel location, and places the selected channel at the top of the CRT screen. [GOTO] XX [ENT], where XX is the No. column on the Main Menu.

[EDIT] -- Allows editing of the locations of the individual PC Card locations on the Main Menu. For example you may want to group all DC Biases, and all Drivers together. See Section 8.2.4 Using the Edit Function.

[INCR] -- Allows incrementing of the Voltage and rise and fall time settings. Voltages can be incremented from 10mv to 100mV in 10mV increments, and rise and fall times can be incremented in steps of 1ns, 10ns, or 100ns. See also High Resolution Mode for additional information on increment settings for Bias PC Cards.

[DECR] -- Allows decrementing of the Voltage and rise and fall time settings. Voltages can be decremented from 10mv to 100mV in 10mV increments, and rise and fall times can be decremented in steps of 1ns, 10ns, or 100ns. See also High Resolution Mode for additional information on decrement settings for Bias PC Cards.

[SET ALL] -- Allows you to set all of the channels to the same value with one command. This softkey works with HLV, LLV, TR, TF, INVERT, NONINV, DELAY, and WIDTH functions. The softkey sets all the Drivers or DC Biases to the value at the location of the cursor, when the softkey is pressed.

[ZOOM] -- Provides a window of additional information on the selected PC Card. Place the cursor on the PC Card channel desired and press the [ZOOM] softkey. You will be presented with a window on the CRT displaying additional information. While in the window mode you may change the parameters on any displayed function desired by selecting the appropriate softkey. You may also change parameters on all Drivers or all Biases in the system while in this mode through the use of the [SET ALL] softkey. Once you have entered the window mode, you can change the window information to display other channels by using the [PREV] and [NEXT] softkeys. To remove the window press the [HOME] key.

8.2.4 Using the Edit Function

When the [EDIT] Softkey is pressed, you will be presented with the following Softkeys.

[GO TO] [MOVE] [SWAP] [INSERT] [DELETE] [EXIT]

[GO TO] -- The [GO TO] Softkey is used to select the channel from the No. Column, by pressing the [GO TO] Softkey and the number of the channel you wish displayed.

[MOVE] -- Allows you to Move the channel to the desired location. To Move the channel, place the cursor on the channel, and press the [MOVE] Softkey. You will then be asked for the new location for the channel. Enter the new location, press [ENT], and the channel will be moved.

[SWAP] ---- Allows you to swap two selected channels.

[INSERT] -- Adds a line at the point of the cursor.

[DELETE] -- Deletes the line at the point of the cursor.

[EXIT] ---- Takes you out of the Edit Function.

8.2.5 Setting And Using The Programmable Rise And Fall Time - 40460 Driver PC Card

The Programmable Rise and Fall time function allows the setting of the individual rise and fall times of the channel outputs throughout the range of 40ns representing a minimum 2ns/V rise time all the way up to 2000ns/V. The ranges are shown below.

Minimum	Maximum	Slew Rate	Inc/Dec Value
Range 1 40ns	400ns	2ns/V	1ns
Range 2 400ns	4000ns	20ns/V	10ns
Range 3 4000ns (4usec)	40000ns (40usec)	200ns/V	100ns

When Any voltage is changed on the 40460 Driver output, the Tr and Tf ranges are automatically re-calculated to display the same slew rate that was being used before the change, unless the current rise or fall time setting is Protected from change. See Section 8.3.1 [TR PROTECT] and [TF PROTECT] Softkeys, for information on protecting the rise and fall time settings.

The rise and fall times must always be set on the same range to prevent the setting of the rise time from effecting the setting of the fall time or vice versa. If an attempt is made to set either the Rise Time or Fall Time ranges incorrectly, there will be no change in the setting, and an " Out of Range" message will

be presented.

Since the minimum slew rate of the Driver PC Card is 2ns/V, the software is designed to look at the Voltage levels between the high and low settings on each driver channel and automatically set the lowest range setting, as the default condition. This is the lowest value, or the value corresponding to a Tr or Tf of 2ns/V, based upon the voltage differential (HLV-LLV). If you have previously set the rise and fall times to the value that you require, the system will default to your pre-set slew rate, if any voltages are changed.

Once the default setting of the Tr/Tf is accomplished, the value of the Tr/Tf can be changed by placing the cursor on the proper channel, and inputting the new setting with the data keys. If you enter an illegal value the CRT will display the error message: "out of range". This means that the Tr or Tf that you have selected based on the voltage setting of the channel is out of the range of 2ns/V minimum and 2000ns/V maximum setting.

You can set any value desired based upon the guidelines of the chart above. For example, if you enter a value of HLV 10.000, and an LLV of 0.000, you will note that the default setting of Tr/Tf is 20ns, which is within the 2ns/V minimum setting. If you tried to Decrement this value 1ns to a value of 19ns, you would get an "out of range" error message since the value you were trying to set was 1.9ns/V, or out of minimum range.

The value of the Increment/Decrement Softkeys depends on the range. The chart above shows that the value changes by a factor of 10 times as you increase the range. As you get near the end of any range, you will notice a message that will ask you to select the operating range that you wish to use.

For example, as you approach the end of Range 1, which would be approximately 390ns, the following message will appear: "Select range for 2ns/V or range 2 for 20ns/V (Enter 1 or 2)". You may at that time elect to stay on range 1, that you are using, which allows a maximum of 400ns in 1ns increments, or to change to range 2, which has a range from 400ns to 4000ns in 10ns steps. If you select between these ranges you will notice an overlap of about one step or 10ns, or 100ns depending upon the range.

NOTE: THE RISE AND FALL TIME SETTINGS MUST ALWAYS BE ON THE SAME RANGE AS SHOWN ON THE CHART. For example, you cannot set a rise time of 40ns and a fall time of 4000ns, since these values are not within the same range.

This is also true for access over the IEEE-488 bus or through the RS-232-C Port.

8.2.6 Voltage and Current Sense

The Voltage or Current Sense output on the PI-4002 Instrument Mainframe can be used to measure the load current of the 40460 Driver PC Card, or the exact Voltage output of either the high or low rail. In the current sense mode, the SENSE column on the Main Menu indicates the channel that is currently being sensed, and whether the PC Card is set for Current or Voltage sense. You should not have the Current Sense in effect while the Data Generator is running, since you will improperly terminate the output with the Current Sense series resistors.

The Voltage and Current Sense measurements are taken from the I/V Sense Port on the rear of the PI-4002 Instrument Mainframe.

All the I/V Sense ports can be tied together in parallel and multiplexed throughout the system to share a common DVM.

The multiplexed output is available at the dual BNC Output on the rear of the PI-4002 Instrument Mainframe. The output is taken between the two center pins of the dual BNC Connectors. DO NOT MEASURE OR USE EITHER BNC CENTER PIN TO GROUND AS A METHOD OF MEASUREMENT.

The upper BNC Pin is negative with respect to the lower BNC Pin. Therefore, the upper BNC Pin should be connected to the minus or input low of a DVM with 4 1/2 digit capability, if possible. There is a reversal of polarity between current and voltage measurements between these pins.

The DVM should be set to the 1 Vdc range. You should use a BNC to Dual Banana adaptor and take the signal only from the center pin portion of the BNC output on both "+" and "-" sense outputs

There should be a load connected to the driver output that is to be measured.

8.2.7 Current Sense Measurement Using the DVM.

The current output is the DVM voltage multiplied by the selected current range.

For example; if the DVM reading was .987 V, and you were on the 25mA/V range, the output current would be 24.675 mA, ie...

(.987 X 0.025)

When taking Current measurements, the sensing Voltage output range on the DVM should not exceed 2.5 Vdc, or the next higher Current Sense range for the channel you want to measure should be selected.

With no signal applied to the Driver input, the Current measurement is the High Rail (HLV) with an inverted output setting, and the Low Rail (LLV) with the output setting in the noninverted mode. The Invert and NonInvert functions can be set for all channels in the system with the [SET ALL] softkey, from any Driver PC Card in the Zoom Mode window.

The Driver current can be measured with signal applied, but this will only provide the average current based upon the pulse width and frequency of the output.

1 mA/V	1k Ohms
10 mA/V	100 Ohms
25 mA/V	40 Ohms

Internal Range Resistance values
of the 40460/40461 Driver PC Cards.

The range resistors are not in the direct output path of the Drivers.

The Current Sense Mode is not available on the 40480 50MHz Driver PC Cards.

There should be a load connected to the bias supply output that is to be measured. For example: 10k Ohms.

For example; if the DVM reading was .987 V, and you were on the 10mA/V range, the output current would be 9.87 mA.

The internal range resistances for current measurements of the Bias PC Cards are as follows:

1mA/V	1000 Ohms
10mA/V	100 Ohms
100mA/V	10 Ohms

Internal current range resistance
40740, 40741, and 40750 Bias PC Cards

8.2.8 Voltage Sense -- Main Menu.

Voltage Sense allows reading of the actual voltage output of the channel selected by the position of the cursor. The Voltage sense output on the PI-4002 Instrument Mainframe can be used to measure the voltage output of any driver output on the Driver Status and Set Up Menu. Unless the Current Sense Mode has been selected, the Voltage Sense is always available at the channel of the cursor location. It has no effect on the output signal.

Basically, the Voltage Sense Output is a Voltage divider that takes the output Voltage from the selected channel, and either reads it directly on the 2 V range, for output Voltages below 2 Volts, or divides it by ten on the 20 V range to allow reading of Voltages above 2 Volts. All of the system PC Cards use the 2 V and 20 V ranges, with the exception of the 40480 50 MHz PC card, which uses the ranges of 20V and 200V.

In the Voltage Sense mode, the SENSE column on the Main Menu indicates the channel that is currently being sensed.

8.2.9 Setting The High Resolution Mode on the DC Bias PC Cards.

The High Resolution Mode allows adjustment of the Bias Voltage output at the cursor location in the increments listed below for the particular DC Bias PC Cards in your system.

PC Card	Low Res.	High Res.	
40740	10 mV	0.5 mV	
40741	12.5 mV	0.625 mV	
40750	10 mV	0.5 mV	High Range ± 20 V Setting
40750	10 mV	0.250 mV	Low Range ± 10 V Setting

NOTE: The High Resolution Mode is achieved by sacrificing one channel of bias output for each channel that is set up to be incremented or decremented in the High Resolution ranges as opposed to the 10 mV default range. The channels involved must be on the same PC Card.
The High Resolution Mode can only be selected for the ODD-numbered channels, since the EVEN-numbered channels are added to the odd-numbered channels to achieve the mode. For example, if you select channel one for high resolution output, then channel two would be sacrificed to allow you to to achieve the required resolution.

Whenever an even channel has been sacrificed for the High Resolution mode, the resolution column for that channel will display H-R. This display indicates that the even channel is

functioning in conjunction with the odd channel directly above it to set the High Resolution Mode. Do not use the channel labelled H-R as an output channel while in the High Resolution Mode.

The cursor does not access the Resolution Column.

8.2.10 Setting Driver and DC Bias Limits

Each DC Bias Channel and The High and Low Rails of the drivers, can be set for the maximum Voltage limits that you would ever want to see applied to a particular device.

This feature will prevent over-Voltage of the Device Under Test by an accidental over-Voltage of any channel that is connnected to the Device Under Test.

Driver Cards Limits Setting allows you to set the High and Low Rails of the Drivers (Upper and Lower Limits), and the maximum Voltage amplitude of the output signal of each channel.

Bias Cards Limits Setting allows you to set the Upper and Lower limits of each DC Bias Channel. For example, you may want the DC Biases to only be adjusted between the range of 9 V (lower limit) and 11 V (upper limit).

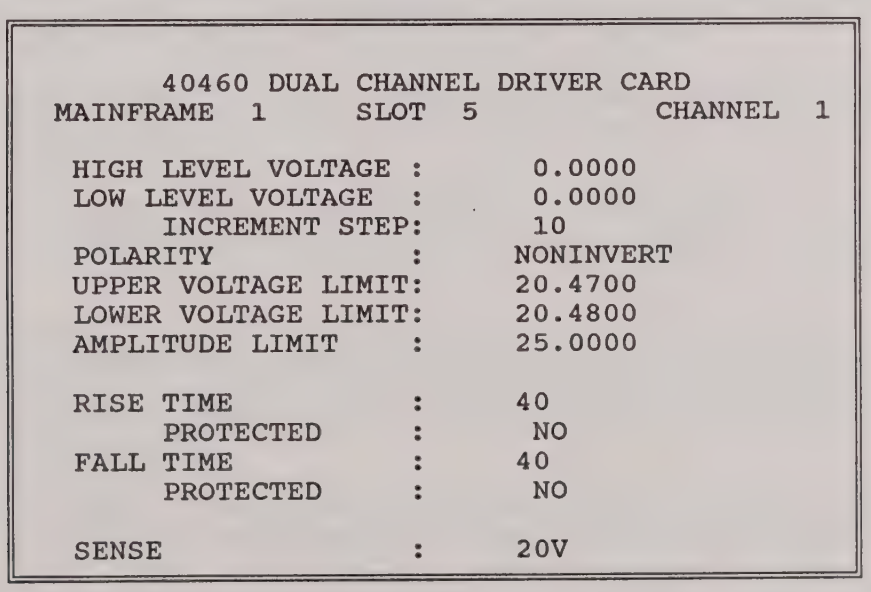
8.3 WINDOWS IN THE ZOOM MODE

The following section will explain the window information that is presented for each PC Card when the [ZOOM] softkey is pressed. To use the Zoom Mode, place the cursor on the desired channel row and press the [ZOOM] Softkey. To remove the window press the [HOME] Key.

Any parameter can be changed for all similar PC Cards in the system by using the [SET ALL] Softkey.

The [PREV] and [NEXT] Softkeys can be used to select the channels in sequence as they appear in the Data Base format when the Zoom Mode is not in use.

8.3.1 40460 Dual Channel Driver PC Card Window


40460 DUAL CHANNEL DRIVER CARD
MAINFRAME 1 SLOT 5 CHANNEL 1
HIGH LEVEL VOLTAGE : 0.0000
LOW LEVEL VOLTAGE : 0.0000
INCREMENT STEP: 10
POLARITY : NONINVERT
UPPER VOLTAGE LIMIT: 20.4700
LOWER VOLTAGE LIMIT: 20.4800
AMPLITUDE LIMIT : 25.0000
RISE TIME : 40
PROTECTED : NO
FALL TIME : 40
PROTECTED : NO
SENSE : 20V

[TR PROTECT] [TF PROTECT] [INCR] [DECR] [SET ALL] [INV/NOINV]

8.3.1.1 Settable Parameters 40460 Dual Channel Driver PC Card Window

1. High Level Voltage -- Sets the High Rail of the output of the PC Card. The difference between the high level Voltage and the low level Voltage cannot exceed 25 Volts. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

2. Low Level Voltage -- Sets the Low Rail of the output of the PC Card. The difference between the Low Level Voltage and the

High Level Voltage cannot exceed 25 Volts. The LLV or Low Level Voltage must always be set below or equal to the HLV or High Level Voltage.

3. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10 mV to 100 mV in 10 mV increments when used to set the High or Low Level Voltage output.

4. Polarity -- Sets the output to either inverted or noninverted.

5. Upper Voltage Limit -- Allows High Level Voltage of the Driver PC Card to be set to the maximum Voltage Limits that you would ever want to see applied to a particular device.

6. Lower Voltage Limit -- Allows Low Level Voltage of the Driver PC Card to be set to the minimum Voltage Limits that you would ever want to see applied to a particular device.

7. Amplitude Limit -- Sets maximum Voltage amplitude that the Driver PC Card can output. The maximum amplitude for the 40460 Driver PC Card is 25 V.

8. Rise Time -- Sets the programmable Rise Time. See Section 8.2.5 for information on setting the Programmable Rise and Fall Time.

9. Protected -- Allows you to protect the setting of the Rise Time with changes in the settings of the High and Low Level Rails. In the not protected mode, the rise time will be recalculated to maintain the slew rate that existed before the change in amplitude.

10. Fall Time -- Sets the programmable Fall Time. See Section 8.2.5 for information on setting the Programmable Rise and Fall Time.

11. Protected -- Allows you to protect the setting of the Fall Time with changes in the settings of the High and Low Level Rails. In the not protected mode the Fall time will be recalculated to maintain the slew rate that existed before the change in amplitude.

12. Sense -- Toggles the Voltage and Current Sense setting desired for this particular PC Card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of PC Cards in the system. The Toggled settings for this PC Card are; 20 V, 2 V, 1 mA, 10 mA, and 100 mA.

8.3.1.2 Softkeys 40460 Driver PC Card Window

[TR PROTECT] -- Toggles the Rise Time Protect feature on and off. The protect feature allows you to change Voltage levels while maintaining the same slew rate, which means that the rise time would change with a change in Voltage, or change Voltages while maintaining the same rise time.

[TF PROTECT] -- Toggles the Fall Time Protect feature on and off. The protect feature allows you to change Voltage levels while maintaining the same slew rate, which means that the fall time would change with a change in Voltage, or change Voltages while maintaining the same fall time.

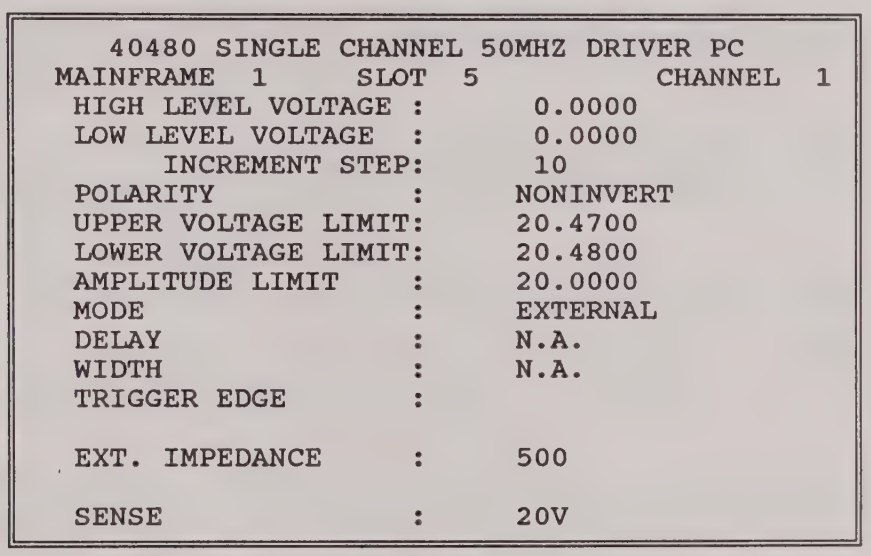
[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the values of the Voltages and Rise and Fall Times.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the values of the Voltages and Rise and Fall Times.

[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor. [SET ALL] will set the parameters for all Drivers, regardless of model number, or all Biases regardless of model number.

[INV/NOINV] -- Toggles the Invert and Non Invert function of the output.

8.3.2 40480 Single Channel 50 MHz Driver PC Card Window



[TOGGLE MODE] [TGL.TRIGGER] [INCR] [DECR] [SET ALL] [INV/NOINV]

8.3.2.1 Explanation of Settable Parameters 40480 50 MHz Driver PC Card

1. High Level Voltage -- Sets the High Rail of the output of the PC Card. The difference between the high level Voltage and the low level Voltage cannot exceed 20 Volts. The HLV or High Level Voltage must always be set above or equal to the LLV or Low Level Voltage.

2. Low Level Voltage -- Sets the Low Rail of the output of the PC Card. The difference between the Low Level Voltage and the High Level Voltage cannot exceed 20 Volts. The LLV or Low Level Voltage must always be set below or equal to the HLV or High Level Voltage.

3. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10mV to 100mV in 10mV increments when used to set the High or Low Level Voltage output.

4. Polarity -- Sets the output to either inverted or noninverted.

5. Upper Voltage Limit -- Allows High Level Voltage of the Driver PC Card to be set to the maximum Voltage Limits that you would ever want to see applied to a particular device.

6. Lower Voltage Limit -- Allows Low Level Voltage of the Driver PC Card to be set to the minimum Voltage Limits that you would ever want to see applied to a particular device.

7. Amplitude Limit -- Sets maximum Voltage amplitude that the Driver PC Card can output. The maximum output amplitude for the 40480 Driver PC Card is 20 V.

8. Mode -- Displays either the External, Internal Width, Internal Delay/Width, or Double Pulse Mode. See Section 8.3.2.3 for an explanation of these Modes.

9. Delay -- Provides the current setting of the Delay of the channel if the Internal Delay/Width Mode has been selected.

10. Width -- Provides the current setting of the Width of the channel output if either the Internal Width Mode, or the Internal Width/Delay Mode has been selected.

11. Trigger Edge -- Sets the selection of the edge of the input trigger to either the rising or falling edge. This can be set with either the [TGL.TRIGGER] or the [INCR] [DECR] Softkeys.

12. Ext. Impedance -- Selects either 500 Ohms or 50 Ohms input impedance at the TTL Input to match the requirements of your clock source for high speed applications.

13 Sense -- Toggles the Voltage Sense setting desired for this particular PC Card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of PC Cards in the system. The Toggled settings for this PC Card are; 20V and 200V.

8.3.2.2 Softkeys 40480 Driver PC Card Window

[TOGGLE MODE] -- Selects either the External, Internal Width, Internal Delay/Width, or Double Pulse Mode. See Section 8.3.2.3 for an explanation of these Modes.

[TGL TRIGGER] -- Selects the Driver PC Card Trigger output to supply the trigger on either the rising or the falling edge of the signal being supplied to the input of the PC Card. See Section 8.3.2.3 for an explanation of the relationship between the Modes and this trigger function.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the values of the Voltages and Rise and Fall Times.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the values of the Voltages and Rise and Fall Times.

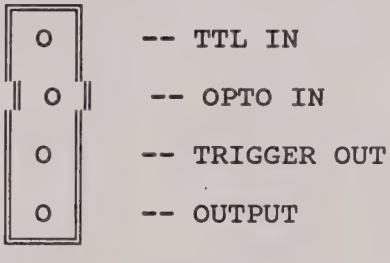
[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor.

[INV/NOINV] -- Toggles the Invert and Non Invert function of the output.

8.3.2.3 Mode functions for the 40480 50 MHz Driver PC Card.

The 40480 Driver PC Card allows you to set internally, the output width and delay of the input signal to the PC Card. This function can be independent of the input signal or directly dependent, depending upon the mode and trigger selected.

The BNC connectors on the rear of the 40480 Driver PC Card are as follows:



TTL IN -- Direct input to the PC Card. Not optically isolated, will allow up to 50 MHz Input to the PC Card, producing up to 50 MHz Output.

OPTO IN -- Optically isolated input. Will allow maximum 20 MHz input to the Driver PC Card, and maximum 20 MHz output.

TRIGGER OUT -- Trigger output for use with oscilloscopes or other functions. Also the reference for Internal Width and Delay features.

OUTPUT -- Output of the Driver PC Card.

Input Signal

External Mode
(Output Follows
Input Signal)

Trigger Out
(Set on Rising or Falling
Edge of Input Signal)

Internal Width Mode
(Rising Edge is
referrenced to
Trigger Out)

Internal Delay/Width Mode
(Rising Edge is
referrenced to
Trigger Out)

Double Pulse Mode
(Rising Edge is
referrenced to
Trigger Out)

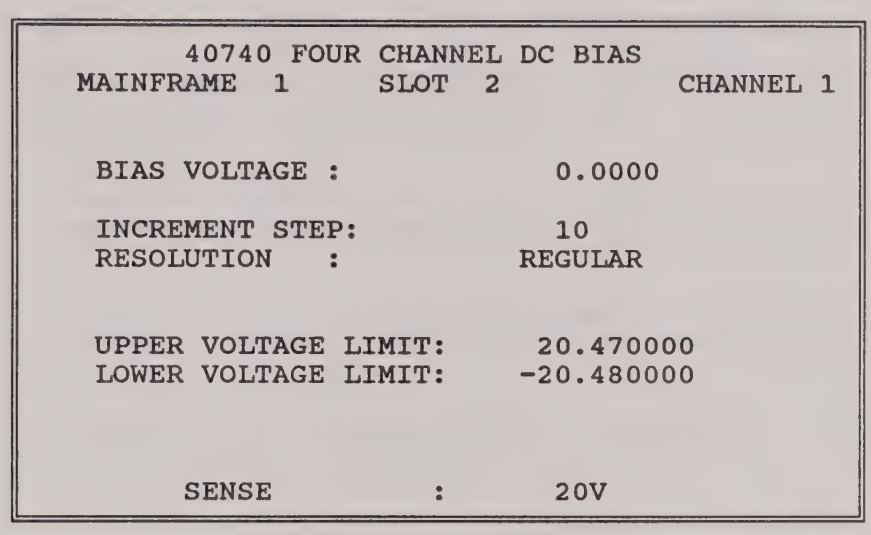
The waveforms above show the relationship of the Input signal to the adjustments that can be made to the output of the 40480 Driver PC Cards.

In the External Mode, the output of the Driver is the same in terms of width and delay as the input signal. The output follows the input.

If any of the two Internal Modes are selected, the output pulse is referrenced to the Trigger Out, which can be set to occur on the rising edge of the input signal, or the falling edge of the input signal.

This relationship is shown above by the slight delay of the Trigger Output with respect to the input signal in the diagram above. The diagram shows the trigger to be occurring on the rising edge of the input signal. The Internal Width Mode, is then measured from the Trigger out edge.

8.3.3 40740 Four Channel DC Bias PC Card Window


40740 FOUR CHANNEL DC BIAS
MAINFRAME 1 SLOT 2 CHANNEL 1
BIAS VOLTAGE : 0.0000
INCREMENT STEP: 10
RESOLUTION : REGULAR
UPPER VOLTAGE LIMIT: 20.470000
LOWER VOLTAGE LIMIT: -20.480000
SENSE : 20V

[HI/REG RES] [ ] [INCR] [DECR] [SET ALL] [ ]

8.3.3.1 Settable Parameters 40740 DC Bias PC Card Window

1. Bias Voltage -- Sets the Voltage of the output of the selected PC Card channel. The Voltage output for the 40740 DC Biases can be set anywhere in the range from +20.47 Vdc to -20.48 Vdc.

2. Increment Step -- Allows setting of the value of the increment step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10mV to 100 mV in 10mV increments when used to set the DC Bias Voltage output.

3. Resolution -- Selectable as either High or Regular Resolution with the [HI/REG RES] Softkey. See Section 8.2.9 For information on High Resolution Mode.

4. Upper Voltage Limit -- Allows High Voltage Limit of the Bias PC Card to be set to the maximum Voltage Limit that you would ever want to see applied to a particular device.

5. Lower Voltage Limit -- Allows Low Voltage Limit of the Bias PC Card to be set to the minimum Voltage Limit that you would ever want to see applied to a particular device.

6. Sense -- Toggles the Voltage Sense setting desired for this particular PC Card. You can use the [SET ALL] Softkey while on

this parameter to set all of the same type of PC Cards in the system. The Toggled settings for this PC Card are; 20 V, 2 V, 1 mA, 10 mA, and 100 mA.

8.3.3.2 Explanation of Softkeys 40740 DC Bias PC Card

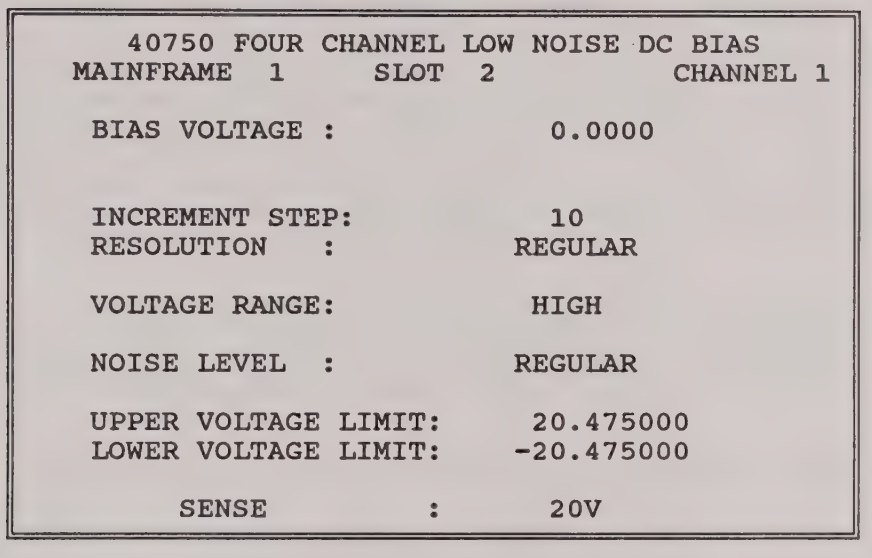
[HI/REG RES] -- Toggles the Resolution of the channel at the cursor between High and Regular Resolution. See Section 8.2.9 High Resolution Mode.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the Voltage setting.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the Voltage setting.

[SET ALL] -- Sets all of the channels in the system to the same value as the parameter at the cursor.

8.3.4 40750 Low Noise Four Channel DC Bias PC Card


40750 FOUR CHANNEL LOW NOISE DC BIAS
MAINFRAME 1 SLOT 2 CHANNEL 1
BIAS VOLTAGE : 0.0000
INCREMENT STEP: 10
RESOLUTION : REGULAR
VOLTAGE RANGE: HIGH
NOISE LEVEL : REGULAR
UPPER VOLTAGE LIMIT: 20.475000
LOWER VOLTAGE LIMIT: -20.475000
SENSE : 20V

[HI/REG RES] [LO/REG NOISE] [INCR] [DECR] [SET ALL] [HI/LO RANGE]

8.3.4.1 Explanation of Settable Parameters 40750 Low Noise Bias PC Card Window

1. Bias Voltage -- Sets the Voltage of the output of the PC Card.

2. Increment Step -- Allows setting of the value of the Increment Step when the [INC] or [DEC] Softkeys are used. The Increment Step can be set from 10mV to 100mV in 10mV increments when used to set the DC Bias Voltage output.

3. Resolution -- Selectable as either High or Regular Resolution with the [HI/REG RES] Softkey. See Section 8.2.9 For information on High Resolution Mode.

4. Voltage Range -- Displays the current range setting of the PC Card, High or Low. The High Range for this PC Card is from -20.48 Vdc to +20.47 Vdc. The Low Range for this PC Card is from -10.245 Vdc to +10.235 Vdc. This range provides the lowest output noise. See Section 3.0 Specifications for information on the noise differences between these two modes.

5. Noise Level -- Provides an indication of the current Noise Level Mode of the 40750 PC Cards, either Low Noise Mode or Regular Mode. The Low Noise Mode provides the lowest output noise level, and the regular mode provides 100 msec faster response to changes in Voltage when the Voltage setting is changed.

6. Upper Voltage Limit -- Allows High Voltage Limit of the Bias PC Card to be set to the maximum Voltage Limit that you would ever want to see applied to a particular device.

5. Lower Voltage Limit -- Allows Low Voltage Limit of the Bias PC Card to be set to the minimum Voltage Limit that you would ever want to see applied to a particular device.

6. Sense -- Toggles the Voltage Sense setting desired for this particular PC Card. You can use the [SET ALL] Softkey while on this parameter to set all of the same type of PC Cards in the system. The Toggled settings for this PC Card are; 20 V, 2 V, 1 mA, 10 mA, and 100 mA.

8.3.4.2 Softkeys 40750 Low Noise DC Bias PC Card Window

[HI/REG RES] -- Toggles the selected channel between High Resolution and Regular Resolution. See Section 8.2.9 High Resolution Mode.

[INCR] -- Toggles the available parameters or values of the function presently at the cursor. Also increments the setting of the Voltage.

[DECR] -- Toggles the available parameters or values of the function presently at the cursor. Also decrements the setting of the Voltage.

[SET ALL] -- Sets all of the channels of the same type in the system to the same value as the parameter at the cursor.

[HI/LO RANGE] -- Togggles the High and Low Range Setting of PC Card. The Voltage output for the 40750 DC Biases can be set anywhere in the range from +20.47 Vdc to -20.48 Vdc, in the High Range Mode and from -10.245 Vdc to +10.235 Vdc in the Low Range Mode.

8.4 INTERFACE MENU

```
          4000 SERIES FPA TEST SYSTEM    INTERFACE MENU
VERSION 3.12                          STATUS: OFFLINE : LOCAL

       IEEE INTERFACE    :
            IEEE ADDRESS :          7
          SERVICE REQUEST:        OFF
       RS232 INTERFACE   :
            BAUD RATE:           1200
            STOP BITS:              1
            PARITY   :           OFF
  KEYBOARD INTERFACE :
     AUTO REPEAT KEY :             ON

[SRQ]  [BAUD (↓)]  [BAUD (↑)]  [STOP BITS]  [PARITY] [AUTORPT]
```

8.4.1 General

The Interface Menu provides the status of the IEEE-488 GPIB and RS-232-C functions. In the IEEE-488 portion of the menu, is displayed the IEEE-488 instrument address that is currently set. To change the address, set the new number on the DIP-Switch located on the rear of the PI-4001 Control Mainframe in slot A. Reset the system, by simultaneously pressing [HOME] and [CE], to bring up the new address.

The STATUS display provides a return over the IEEE-488 bus of the On Line and Off Line condition of the unit, as well as any errors pending. See 9.0 IEEE-488 Programming.

8.4.2 Explanation of Softkeys

There is one page of softkeys used with the Interface Menu.

[SRQ] [BAUD (↓)] [BAUD (↑)] [STOP BITS] [PARITY] [AUTO RPT]

Any bus programming errors can be cleared by pressing any key

while on this display. Sending the command STATUS during IEEE-488 or RS-232-C operation will provide you with an indication of any error that is pending. These errors must be cleared to continue operation. See Section 9.2.2 STATUS Command.

[SRQ] -- Toggles the Service Request on and off.

[BAUD RT(↓)] -- Toggles the available Baud Rate settings downward from 19,200 to 110 Baud.

[BAUD (↑)] -- Toggles the available Baud Rate settings upward from 110 Baud to 19,200 Baud.

[STOP BITS] -- Toggles the Stop Bit settings. The Stop Bit setting on the Interface Menu must match the Stop Bit setting of the controller.

[PARITY] -- Toggles the Parity settings. The Parity setting on the Interface Menu must match the Parity setting of the controller.

[AUTO RPT] -- The [AUTO RPT] Softkey allows you to toggle the [INCR] and [DECR] softkeys to select either auto repeat or one setting per press of the softkey.

For example, if Auto On is selected, pressing the [INC] softkey will allow no movement in the setting after the first increment for one-half second. After one-half second, continuing to press the key will store incremental settings at the rate of 15 settings per second that the key is pressed.

The status of this feature is displayed on the CRT at all times on this menu.

9.0 PROGRAMMING THE 4000 SERIES LOW NOISE TEST SYSTEM

9.1 CHANGES IN VERSION 2.XX and 3.XX SOFTWARE

If you are not familiar with programming the 4000 Series System, go directly to section 9.2

If you are familiar with programming the 4000 Series System in software versions before and including 2.00, all your existing software should function properly with the new version 3.00 software. This section will outline the changes in Version 3.00.

The High and Low Resolution functions and the Current and Voltage Sense functions have been modified to ease the programming task.

The following commands have been DELETED, however they have been left in the software to allow your existing software to still function properly. Many of these deleted commands have been left in this manual, so that you may refresh your memory as to their useage. They will be treated in Version 3.00 as follows:

LABEL -- The label that you establish can now be used to access channels in place of the mainframe, slot, channel commands.

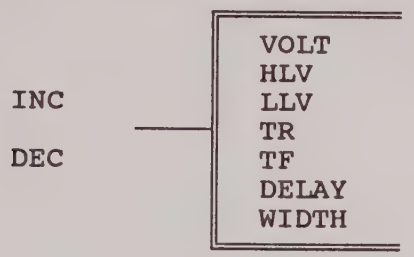
VSENSEOFF -- Now the same as the DESELECT command.
ISENSEOFF -- Now the same as the DESELECT command.
HR10 -- Treated the same as the new HR command.
HR12.5 -- Treated the same as the new HR command.
HR05 -- Treated the same as the new LR command
HR0.625 -- Treated the same as the new LR command.
HR1 -- Treated the same as the new LR command.

RANGE1 -- No longer required. You will get an error if you enter an out of range rise and fall time combination.

RANGE2 -- No longer required. You will get an error if you enter an out of range rise and fall time combination.

RANGE3 -- No longer required. You will get an error if you enter an out of range rise and fall time combination.

CINC, FINC, CDEC, FDEC -- These commands would increment or decrement the last setting of Voltage or Rise and Fall Time. (they can still be used), but have been replaced with:



In the form: INC VOLT or DEC DELAY

In the new structure you can set the ISENSE or VSENSE on any Driver or Bias channel and leave the setting in place, and access the setting with the SELECT command at any time you wish to take a reading. You can also now set ALL ISENSE or VSENSE, which will greatly simplify programming. You can also mix the functions as desired and leave the settings. For example Bias channel 1 could be ISENSE1, Bias Channel 2 could be VSENSE2 etc..

The Voltage and Current sense functions are both turned off with the DESELECT command. This command affects all of the Driver and DC Bias channels in the system, and remains in effect until the receipt of any other Voltage or current setting, or the SELECT command. YOU SHOULD NOT LEAVE DRIVER PC CARDS IN THE ISENSE MODE WHEN BEING DRIVEN BY THE DATA GENERATOR, SINCE THIS WILL PLACE A SERIES RESISTANCE IN THE OUTPUT AND DEGRADE THE OUTPUT VOLTAGE AND WAVEFORM.

After the DESELECT command has been sent, any VSENSE or ISENSE command sent will turn the sense function back on, but you will not get an output from the sense function until a channel is selected with the SELECT command.

The new commands for the resolution functions are HR (High Resolution) and LR (Low Resolution).

With the 90040 Non-Volatile Memory Option, you can store up to 64 complete instrument set ups, which also include Programmable limits on the Voltage output settings of the Drivers and Biases. These limits as well as complete instrument settings can be placed in a default file that will automatically load the settings and limits upon power up.

The limits can also be programmed over the bus without the presence of the 90040 Non-Volatile Memory Option, but they cannot be saved internally or automatically loaded upon power up. The

Non-Volatile Memory can be fully utilized over the IEEE-488 Bus or through the RS-232-C Port. However, you will not have the Limits Setting Menus, without the option being present.

9.2 IEEE-488 GPIB PROGRAMMING

9.2.1 General

The PI-4001 Control Mainframe contains the PC Cards that are necessary for operation of the system over the IEEE-488 Bus, through the use of simple statements. These statements are listed in section 9.2.

During IEEE-488 operation, you can be on any menu in the system.

When in the Remote Mode, during IEEE-488 operation, the [MORE] Softkey becomes [LOCAL] to allow you access to the softkeys and to remove the unit from Remote Mode.

NOTE: TERMINATE ALL COMMAND LINES WITH A <CARRIAGE RETURN>, <LINE FEED>, AND AN EOI. TRANSMISSIONS FROM THE PI-4001 WILL BE TERMINATED SIMILARLY.

Below is an example of a correctly terminated command line. Also note that the SPACES ARE REQUIRED as shown. All command lines are required to be terminated in this manner:

MF 2 SLOT 3 CH 2 HLV 10.5+<CR> <LF>

OR: "MF 2 SLOT 3 CH 2 HLV 10.5"+chr$(13)+chr$(10)

Sample Command Strings

The PI-4001 does not require use of capital letters, but spaces are required.

If the unit goes into remote mode, but appears not to be functioning properly when a command string is sent, send the string: status+chr$(13)+chr$(10)

The status string coming back will provide you with an indication of why the string was not received properly, by giving back an error message, which will be displayed as a number at the status location on the Interface Menu. The error message numbers are explained in Section 12.2.1. THE UNIT WILL NOT RECEIVE PROPERLY IF THERE IS AN ERROR PENDING. IT MUST BE CLEARED BY SENDING THE STATUS COMMAND.

All commands are required to take one of the following two forms. In form 1, the mainframe, slot, and channel location are accessed with the command. In form 2, a label assigned to the channel is used instead of the mainframe, slot, channel sequence.

The First form of command structure is as follows:

MAINFRAME num SLOT num CHANNEL num mode value+chr$(13)+chr$(10)

In the form: MF 2 SLOT 6 CH 2 LLV -5.0+chr$(0D)+chr$(0A)

Where:

MF	- Refers to mainframe
NUM	- Is the number of the mainframe or slot or channel you want to access.
SLOT	- Is the slot location within a particular mainframe.
CH	- Is a particular channel within the slot.
Mode	- The function you want to perform, ie... HLV is the mode to set the high voltage level.
VALUE	- Any numerical parameters associated with the mode. ie...5.25 as the high level voltage, if a value is required.
ALL	- Can be used to set all channels at one time. See ALL Command in section 9.2.3 Mode Commands.

NOTE: IN ALL EXAMPLES BELOW THE CARRIAGE RETURN AND LINE FEED WILL NOT BE SHOWN FOR CLARITY.

Once you have established the mainframe number, or the slot number, you can continue sending to the same slot without re-sending the mainframe number, or the slot number, until you require a change in mainframe number or slot number. For example if you are working within the same mainframe, you can send:

slot 5 ch 2 llv -5.5

Once you have established the mainframe reference, you could also continue from here within the same slot with the command:

ch 1 CINC

Once you have accessed a location, you can send up to 2048 characters within the string, ex...

MF 2 slot 3 ch 1 hlv 10.0 LLV -10.2 tr 40 tf 380

The Second form of command structure is as follows:

The label assigned to a particular channel can also be used to program the channel. (See the LABEL command in the programming section for details).

First you must establish the label as representing a particular location with a command referencing the label to a particular channel: ie...

MF 1 SLOT 3 CH 2 Label CLK1

Since you have assigned the label "clk1" to a particular channel, you can now program that channel with the command;

@clk1 HLV 10.00

Note the addition of the @ Sign when the Clk1 label is used as a command.

To change a label or remove the function of the label, use the following commands:

@clk1 Label *

or, MF 1 SLOT 3 CH 2 Label *

or, ALL LABEL *

WHEN INPUTTING DATA FROM THE PI-4001, EOF, IE...END OF FILE (1a HEX), <CARRIAGE RETURN>, <LINE FEED>, AND AN EOI, WILL BE SENT, WHEN THE UNIT HAS COMPLETED SENDING REQUESTED DATA.

THE PI-4001 WILL NOT RESPOND TO ANY PROGRAMMING COMMANDS IF THERE IS AN ERROR PENDING.

9.3 IEEE-488 COMMANDS

9.3.1 Chart of Commands With Page Numbers Where Discussed

STATUS 62
ONLINE 63
OFFLINE ...63
CLEAR 63
DUMPF 77
DUMPV 77
DUMPT 77
REGULAR ...70
LNOISE 70
HLV 68
LLV 68
INV 68
NONINV 69
LABEL 65
ID 78
DUMPLD 78
DUMPLB 78
LOLIMB 76
LOLIMD 76
AMPLIM 76
DELAY (time) NS,US,MS ..71
WIDTH (time) NS,US,MS ..71
INC 75
DEC 75
IMP50 72
IMP500 72
TR 67
TF 67
VOLT 68
@label name ..65
LABEL * 66
STEP num 75
LR 69
HR 68
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ISENSE1 73
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DISCON 64
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DESELECT 63
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UPLIMD 75
LRANGE 69
HRANGE 70
SELECT 74
RTRIG 72
FTRIG 72
SRQON 64
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VSENSE1 ..73
VSENSE2 ..73
VSENSE3 ..73
EXT 72
INTW 71
INTD 71
DP 71
MF 60
SLOT 60
CH 60
NORM 63
; (REM) ..66

9.3.2 90040 Non-Volatile Memory Option Commands (Page 79)

SAVE num (num is an identification number from 1 to 4096
LOAD num assigned by user to differentiate between saved
DELETE num files)
DIR
DEFAULT
PWRONFILE num

9.3.3 System Commands

The following are system commands that do not require accessing a particular channel and are used in a stand-alone manner.

STATUS -- Sending STATUS provides you with information on On Line/Off Line status, or error messages that may be pending. IF THERE IS AN ERROR PENDING YOU CANNOT LOAD DATA TO THE PI-4001 UNTIL THE ERROR IS CLEARED. THE

ERROR IS CLEARED BY SENDING STATUS AND VIEWING THE ERROR INDICATION IN THE STATUS LOCATION ON THE INTERFACE MENU. The error message numbers are explained in Section 12.2.1.

The status buffer can store up to 4 messages. You have not cleared the status buffer of all available messages until you receive an End of File Marker (1A hex).

The order of appearance of the status message sequence is as follows:

-- The On Line/ Off Line status
-- The error number
-- The error message
-- The end of file marker (1A hex)

CLEAR -- Sending the CLEAR command clears all volatile RAM, and sets the PI-4001 Off Line. You will lose all program information, settings, and the programmable limits will return to the default settings when the Clear Command is used. For more information see the SETDEFB and SETDEFD commands. ex... CLEAR

OFFLINE -- When the PI-4001 is in the On Line mode, sending this command places the outputs off line. The offline and online commands stand alone, and no reference to slot is required. ex... offline

ONLINE -- When the PI-4001 is in the Off Line mode, sending this command places the outputs on line. The ONLINE and OFFLINE commands stand alone, and no reference to slot is required. ex... ONLINE

NORM -- Sets default functions back to normal. NORM is a convenience command that resets the slot to normal. Normal for the DC Bias PC Cards and the Driver PC Cards is shown below:

Normal Conditions: Driver PC Card -- NonInv
Sense Off
10 mV Resolution

Normal Conditions: DC Bias PC Card -- 10 mV Resolution
Sense Off

The command is used as follows, ex... MF 2 SLOT 3 CH 2 NORM

DESELECT -- Turns off the Voltage and Current Sense function. This command acts upon all of the channels in the

system, and turns off the Voltage and Current Sense function until the receipt of any VSENSE, ISENSE, SELECT command. ex...DESELECT

DISCON - Disconnects the outputs of all the channels in the system by first setting all PC Card outputs to 0V and places a small resistance from the outputs to ground to prevent the outputs from coming off 0V. This is also accessable from the front panel by pressing (at present) the Lock Key. The CRT display will show Disconnect in the location where Online and Offline are displayed. The disconnect feature is basically for protection of the device under test since it effectively disconnects the device under test from the test system.

CONNECT -- Connects the outputs back directly into the circuit path and sets all outputs to 0V, and places the instrument in the Offline state. (all outputs connected in the circuit path with 0V out. Programming output Voltage at this point, and placing the system in the Online state will provide Voltage output to the device under test.

SRQON -- Turns on the Service Request

SRQOFF -- Turns off the Service Request

9.3.4 MODE COMMANDS

The following commands are the Mode Commands. These commands are slot dependent, ie...You must reference the location in the form:

MAINFRAME NUM SLOT NUM CHANNEL NUM

MF 2 SLOT 4 ch 2 Mode Value

OR: All hlv 10.0 (If you are setting all channels)

ALL -- Sets all of the channels that use the function in the system to the selected setting or function. The mode commands listed below can be used with the ALL command.

TR	HLV	VSENSE1
TF	LLV	VSENSE2
NORM	INV	ISENSE1
VOLT	NONINV	ISENSE2
DUMPV	FINC	ISENSE3
DUMPT	CINC	DUMPLB
DUMPF	FDEC	DUMPLD
RANGE1	CDEC	SETDEFB
RANGE2	LOLIMB	SETDEFD
RANGE3	LOLIMD	UPLIMB
REGULAR	AMPLIM	UPLIMD
LNOISE	LABEL *	EXT
HRANGE	DELAY	INTW
LRANGE	WIDTH	INTD
		DP

ex... all TR 56
or: all tr 56 tf 56 hlv 5.00 llv -5.023

9.3.5 Label Setting Commands

LABEL -- The LABEL command allows you to place a 4 character identifier on the Main Menu at the Label column and to also use this command to select channels over the IEEE-488 bus or RS-232-C Port.This feature is only available over the IEEE-488 bus or through the RS-232-C port. The channel identifier can be made up of any ASCII characters from A to Z, or from 0 to 9, and the greek character phi. For phi use Chr$(80). The channel identifier can be a maximum of 4 characters and there must be a space inserted between the command LABEL and the identifier for proper formatting on the CRT screen. For example:

MF 1 SLOT 4 CH 2 label CLK3

@LABEL name -- Once you have established the Label, it can be used in place of the standard Mainframe, slot, Channel designation to select channels to access. In the example above,

the label for the channel was designated CLK3. That label can now be used to access the channel as follows:

@clk3 tr 45 tf 45

LABEL * -- Clears the label at the selected channel.

Example: MF 1 Slot 4 CH 2 Label *

or ALL LABEL *

; (REM) -- The Semicolon can be used as a Rem statement in any command line. Once the semicolon is used, the software ignores the information until the next receipt of a carriage return and line feed. for example:

@VSS2 VOLT 10.00 ; Set the VSS2 Bias Voltage

9.3.6 Rise and Fall Time Setting Commands

TR --- Sets the programmable rise time at the selected channel, There are 3 ranges listed below that must be used with this mode command depending upon the range required. The Range settings are as shown in the chart on the next page. Both tr and tf must be on the same range.

TF --- Sets the programmable fall time at the selected channel, There are 3 ranges listed below that must be used with this mode command depending upon the range required. The Range settings are as shown on the next page. Both tr and tf must be on the same range.

The Programmable Rise and Fall time option allows the setting of the individual rise and fall times of the Driver channel outputs throughout the range of 40ns representing a minimum 2ns/V rise time all the way up to 2000ns/V. The ranges are as shown below.

Minimum	Maximum	Slew Rate	Inc/Dec Value
Range 1 40ns	400ns	2ns/V	1ns
Range 2 400ns	4000ns	20ns/V	10ns
Range 3 4000ns (4usec)	40000ns (40usec)	200ns/V	100ns

A command example is as follows:

```
mf 2 slot 4 ch 1  tr 45
```

In the above command, the setting refers to the lower range, which is from 40ns to 400ns. The value, 45, refers to the present rise time setting of 45ns. The value could be any number between 2ns and 400ns on range 1, depending upon the Voltage difference between HLV and LLV. When setting tr and tf, both must be on the same range. For detailed information on this function refer to section 8.1.3 Setting the Programmable Rise and Fall Time.

Once you have selected the mainframe, slot and channel, you can now increment the rise time in one nanosecond increments, the Range 1 setting, with the command: ch1 cinc

9.3.7 Voltage Setting Commands

HLV -- Sets high level voltage mode on the Drivers,

ex... mf 2 slot 3 ch 1 hlv 4.09

LLV -- Sets low level voltage mode on the Drivers,

ex... mf 1 slot 2 ch 2 LLV -5.00

INV -- Inverts the Driver output on the selected channel,

ex... mf 2 slot 3 ch 1 inv

NONINV -- Changes an inverted Driver channel output to true output, ex... mf 3 slot 6 ch 1 noninv

VOLT -- The command, that when used with a value, sets the DC voltage level of the selected bias supply, ex...

mf 4 slot 7 ch 4 volt 10.560

In normal operation the voltage can be set across the bus, in as low as 10mV increments. For voltage adjustments in 0.5 mV or 0.250 mV increments, depending on the Bias PC Card being used, the HR command is required.

HR -- Sets the High Resolution Mode on the selected odd bias channel, while setting the function of the increment/decrement softkeys as shown below. When HR is set, the DC Bias supply selected can be set in as low as 0.5 mV or 0.250 mV accuracy. Setting the HR mode will provide increment/decrement capability as follows:

finc - 0.5, 0.625, 0.250 mV (depending on Card)
cinc - 0.5, 0.625, 0.250 mV (depending on Card)
fdec - 0.5, 0.625, 0.250 mV (Depending on Card)
cdec - 0.5, 0.625, 0.250 mV (depending on Card)

Bias PC Card	Low Res.*	High Res.
40740	10/100 mV	0.5 mV
40741	12.5/100 mV	0.625 mV
40750 (Range 2)	10/100 mV	0.5 mV
40750 (Range 1)	5/100 mV	0.250 mV

* Refers to both Fine/Course Increment and Decrement

In Low Resolution Mode (Command - LR) The Fine Increment/Decrement Commands FINC/FDEC will provide the steps shown above for Fine. The Course Increment/Decrement commands CINC/CDEC will always step at 100 mV.

In High Resolution Mode (Command - HR) either FINC/CINC or FDCE/CDEC will produce the High Resolution value for the selected card model. Once the HR Mode is established, the Voltage can be set in the High Resolution settings with the Volts command.

LR -- Sets the Low Resolution Mode on the selected Bias Channel, or All the Bias channels while setting the function of the increment/decrement softkeys as shown below. When LR is set, the DC Bias supply selected can be set in either Fine or Course Increment/Decrement. the LR mode will provide increment/decrement capability as follows (See HR Command for more information):

finc - 0.5, 0.625, 0.250 mV (depending on Card)
cinc - 100 mV (All Cards)
fdec - 0.5, 0.625, 0.250 (Depending on Card)
cdec - 100 mV (All Cards)

For additional information on the High Resolution Mode, see Explanation of Softkeys, Main Menu, and [HR-ON/OFF] softkey.

FINC -- Fine increments the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 2 slot 5 ch 5 finc

CINC -- Coarse increments the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 4 slot 4 ch 4 cinc

FDEC -- Fine decrements the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 2 slot 5 ch 5 fdec

CDEC -- Coarse decrements the Bias Voltage setting. See LR and HR commands for more information.
ex... mf 4 slot 4 ch 4 cdec

9.3.8 40750 Low Noise DC Bias PC Card Commands

LRANGE -- Sets the 40750 Bias PC Card selected to Low Range operation from -10.245 to +10.235 V. This function sets the entire PC Card, so no channel designation is required. ex...

mf 1 Slot 2 LRANGE
or ALL LRANGE

HRANGE -- Sets the 40750 Bias PC Card selected to Low Range operation from -20.48 to +20.47 V. This function sets the entire PC Card, so no channel designation is required. ex...

```
mf 1 Slot 2 HRANGE
or      all Hrange
```

REGULAR -- Sets the noise output mode of the 40750 PC Card to Regular Mode. This mode does not provide the lower output noise levels of the Low Noise Mode (LNOISE), but improves the response by 100 msec for a 0 to 10 V swing(300 msec). This mode can be set for individual channels. ex...

```
mf 2 slot 3 ch 1 regular
   or    all regular
```

LNOISE -- Sets the noise output mode of the 40750 PC Card to Low Noise Mode. This mode provides lower output noise levels than the Regular Mode (REGULAR), but the response to Voltage changes is 100 msec slower (400 msec), for a 0 to 10 V swing. This mode can be set for individual channels. ex...

```
mf 2 slot 3 ch 1 LNOISE
   or    all LNOISE
```

9.3.9 40480 Single Channel 50MHz Driver PC Card Commands

The commands listed below are used only with the 40480 Driver PC Card.

```
DELAY time NS,US,MS
WIDTH time NS,US,MS

IMP50          IMP500
EXT            INTW
INTD           DP
RTRIG          FTRIG
       VSENSE3
```

Since this PC Card is a single channel PC Card, reference to Channel is always Channel 1. The commands can either take the form:

```
MF 1 Slot 2 ch 1 HLV 5.00  or @clk5 HLV 5.00
```

If you intend to use the internal width and delay settings care must be taken in selecting the proper mode for their use.

The Modes available are:

Mode	Command
External Input	EXT
Internal Width	INTW
Internal Delay/Width	INTD
Double Pulse	DP

Delay and Width Commands
(Used with INTW and INTD)
DELAY time NS,US,MS
WIDTH time NS,US,MS

EXT - External Input -- If you select External Input (Command EXT), you cannot use the internal width or delay setting function. The output delay and width will be the same as the input signal to the Driver.

INTW - Internal Width -- If you select Internal Width, you can set the Width only of the output of the Driver in the range from 8ns to 80ms, by first establishing the Mode (Command INTW) and then sending the Width setting with the Width setting command. The Mode can be set for all 40480 PC Cards in the system or for selected PC Cards.

When the Internal Width Mode command is sent, the Width of the output pulse immediately defaults to minimum setting (8ns) until a command is sent with your required setting. An example is as follows:

MF 2 SLOT 3 CH 1 INTW (Sets Internal Width Mode with default 8ns Width)

MF 2 SLOT 3 CH 1 INTW WIDTH 50 NS (Sets the Internal Width Mode and Sets the Width at 50 nanoseconds.)

or ALL INTW WIDTH 50 ns (Sets all channels to Internal Width Mode at 50 nanoseconds Width.)

Once the Mode has been established, you can change the width as desired. ex...

MF 1 SLOT 2 CH 1 Width 70 ns

INTD - Internal Width/Delay -- This mode is identical in function to the Internal Width mode, with the exception of the addition of delay setting capabilities. The command for this Mode is INTD. The settings for the Width function are in the range from 8ns to 80ms, and the range for the delay function is from 30ns to 80ms.

The commands are used in the same manner as used for the Internal Width Mode. ex...

mf 1 slot 3 ch 1 INTD Delay 50 ns Width 70 ns

The delay and Width can be set independently or together in the same command.

DP -- The Double Pulse Mode will supply a double pulse output from the Driver PC Card, if this mode is selected. The Width and Delay are both adjustable in this mode. The Double Pulse can be set within the range of 14 ns to 80 ms.

mf 1 slot 3 ch 1 DP Delay 50 ns Width 70 ns

RTRIG -- Sets the Trigger out to occur on the Rising Edge of the Input Signal to the Driver PC Card. ex...

MF 2 SLOT 4 CH 1 RTRIG

FTRIG -- Sets the Trigger out to occur on the Falling Edge of the Input Signal to the Driver PC Card.

MF 2 SLOT 4 CH 1 FTRIG

IMP50 -- Selects the 50 Ohms input impedance at the TTL Input to match the requirements of your clock source for high speed applications. ex...

MF 3 SLOT 7 CH 1 IMP50

IMP500 -- Selects the 500 Ohms input impedance at the TTL Input to match the requirements of your clock source for high speed applications. ex...

MF 3 SLOT 6 ch 1 IMP500

9.3.10 Voltage and Current Sense Commands

Any channel can be set with the commands listed below to be in any of the 5 ranges at any time. For example a channel 1 Bias could be set for VSENSE2, while a channel 3 Bias could be set for ISENSE3. The SELECT Command can be sent, at any time, to read the channel output through the Isense/Vsense multiplexed output, and the system will provide whatever reading is set for the particular channel. Once a channel is set for one of the 5 functions, you do not have to mention the function in the commands again unless you want to change the type of reading you are going to take from the channel. The DESELECT command turns off the sense function.

I Sense Ranges		Driver PC Cards	DC Bias PC Cards
ISENSE1	--	1 mA/V	1 mA/V
ISENSE2	--	10 mA/V	10 mA/V
ISENSE3	--	25 mA/V	100 mA/V

ISENSE1 -- Turns on the current sense function for the selected channel. When taking a current measurement or scanning a group of channels, the ISENSE must be turned on, and each channel is selected after setting, with the SELECT command. ex... mf 3 slot 4 ch 2 Isense1

ISENSE2 -- Turns on the current sense function for the selected channel. When taking a current measurement or scanning a group of channels, the ISENSE must be turned on, and each channel is selected after setting, with the SELECT command.
ex... mf 3 slot 5 ch 4 Isense2

ISENSE3 -- Turns on the current sense function for the selected channel. When taking a current measurement or scanning a group of channels, the ISENSE must be turned on, and each channel is selected after setting, with the SELECT command.
ex... mf 3 slot 5 ch 4 Isense3

VSENSE1 -- Turns on the voltage sense function at the selected channel for the 2V range. When taking a voltage measurement or scanning a group of channels, the VSENSE1 must be turned on, and each channel is selected after setting, with the SELECT Command.
ex... MF 3 slot 5 ch 2 Vsense1

VSENSE2 -- Turns on the voltage sense function at the selected channel for the 20V range. When taking a voltage measurement or scanning a group of channels, the VSENSE2 must be turned on, and each channel is selected after setting, with the SELECT Command.
ex... MF 3 slot 5 ch 2 Vsense2

VSENSE3 -- Turns on the voltage sense function at the selected channel for the 200V range. This command is used with the 40480 Driver PC Card only. When taking a voltage measurement or scanning a group of channels, the VSENSE3 must be turned on, and each channel is selected after setting, with the SELECT Command. ex... MF 3 slot 3 CH 1 Vsense3

SELECT -- Allows you to select a preset driver or bias Voltage or current sense function. For example if you had previously set all the DC Bias Channels to the ISENSE3 function, by selecting the required channel and sending the command select you could read the Current on the channel. You can pre-set any driver or bias channel to any Isense or Vsense function and mix them in any way you choose. Sending the SELECT command referenced to a particular channel allows you to take the reading without re-establishing the ISENSE or VSENSE setting again. The DESELECT command turns off the sense function. See 9.3.3 System Commands.

9.3.11 Increment/Decrement Commands

The Increment and Decrement commands can now be referrenced to a particular channel or function in the following form:

Increment Commands	Decrement Commands	PC Cards Used On
STEP num		(All PC Cards)
INC VOLT	DEC VOLT	(All DC Bias PC Cards)
INC HLV	DEC HLV	(All Driver PC Cards)
INC LLV	DEC LLV	(All Driver PC Cards)
INC TR	DEC TR	(All 40460/40461 Driver PC Cards)
INC TF	DEC TF	(All 40460/40461 Driver PC Cards)
INC DELAY	DEC DELAY	(All 40480 Driver PC Cards)
INC WIDTH	DEC WIDTH	(All 40480 Driver PC Cards)

The commands VOLTS, HLV, and LLV require the STEP num command to be used to set the range that is to be incremented or decremented for each type of PC Card. The Steps available for each function are:

Command	Range
Volts	10mV to 100mV in 10mV increments (See also HR Mode)
HLV	10mV to 100mV in 10mV increments
LLV	10mV to 100mV in 10mV increments

The command Step 30 would set the increment and decrement to change in 30 mV Steps. Once this command is sent, it is in use until another STEP num Command is sent. ex...

Step 30 MF 1 SLOT 2 CH 3 INC VOLTS

The Rise and Fall time is used in a similar manner, with the exception that the ranges are changed automatically. See Section 8.2.9 Programming the Rise and Fall Time. ex...

MF 1 SLOT 3 CH 2 INC TR

Tr	1ns (Range 1), 10ns (Range 2), 100ns (Range 3)
Tf	1ns (Range 1), 10ns (Range 2), 100ns (Range 3)

9.3.11.1 Incrementing and Decrementing the Width and Delay

The increment/Decrement ranges for the Width and Delay vary depending upon the value being used. The chart below provides the ranges of Width and Delay and the Increment/Decrement value for each range. The Width or Delay will be incremented based upon the current range value when the command is sent.

MF 1 SLOt 4 CH 1 INC DELAY

Time			Step
14ns	to	1us	100ps
1 us	-	10us	1ns
10us	-	100us	10ns
100us	-	1ms	100ns
1ms	-	10ms	1us
10ms	-	90ms	10us

Chart of Delay and Width Ranges

And Increment/Decrement Step for each range.

9.3.12 Programmable Limits Commands

The programmable limits commands can be used over the IEEE-488 Bus or through the RS-232-C Port even if the 90040 Non-Volatile Memory Option is not installed. In order to save these settings internally after power off, the Non-Volatile Memory Option must be present.

UPLIMD -- Sets the Upper limit of the selected driver channel. This command can be used to reference an individual driver channel, or used to set all of the upper limits of the Drivers in the system. ex...

```
        mf 1 slot 1 ch 1 UPLIMD 10.5
OR      ALL UPLIMD 15.5
```

LOLIMD -- Sets the Lower limit of the selected driver channel. This command can be used to reference an individual driver channel, or used to set all of the lower limits of the Drivers in the system. ex...

```
            mf 1 slot 1 ch 1 LOLIMD -10.5
OR          ALL LOLIMD 0
```

AMPLIM -- Sets the Amplitude Limit of the selected driver channel. This command can be used to reference an individual driver channel, or used to set all of the Amplitude limits of the Drivers in the system. ex...

```
            mf 1 slot 1 ch 1 AMPLIM 5.0
OR          ALL AMPLIM 15.0
```

The maximum amplitude limits of the Driver PC Cards are as follows:

```
40461 Dual Channel High Voltage Driver -- 30 V
40460 Dual Channel Driver PC Card      -- 25 V
40480 Single Channel 50 MHz Driver     -- 20 V
```

UPLIMB -- Sets the Upper limit of the selected DC bias channel. This command can be used to reference an individual DC bias channel, or used to set all of the upper limits of the DC biases in the system. ex...

```
            mf 1 slot 1 ch 1 UPLIMB 10.5
OR          ALL UPLIMB 15
```

LOLIMB -- Sets the Lower limit of the selected DC bias channel. This command can be used to reference an individual DC bias channel, or used to set all of the Lower limits of the DC biases in the system. ex...

```
            mf 1 slot 1 ch 1 LOLIMB 7.55
OR          ALL LOLIMB 5.55
```

SETDEFD -- Sets the default limits of an individual driver channel or all of the drivers in the system. This sets the driver channel or all of the driver channels to maximum to the maximum Voltage output settings for the drivers (Upper Limit +20.47 V, Lower Limit -20.28 V). The CLEAR command will also reset the limits to these default values, as well as setting all driver and bias outputs to 0 V. ex...

```
            MF 1 SLOT 2 CH 1 Setdefd
or          all Setdefd
```

SETDEFB -- Sets the default limits of an individual DC bias channel or all of the DC biases in the system. This sets the DC bias channel or all of the DC bias channels to maximum to the maximum Voltage output settings for the drivers (Upper Limit +20.47 V, Lower Limit -20.28 V). The CLEAR command will also reset all limits to these default values, as well as setting all driver and bias outputs to 0 V. ex...

```
MF 1 SLOT 2 CH 1 SETDEFB
or      all setdefb
```

9.3.13 System Dump Commands

DUMPF -- The dumpf command dumps the format of the system channels to a file for downloading instrument setups. This command requires use of the slot command for selecting the required slot to be dumped, or use of the all command to dump the format of the instument. This command should be used in conjunction with the dumpv and dumpt commands, which allow you to download the rise/fall time and voltage setups. The mainframe, slot and channel must be accessed with this command unless the ALL command is used ex... MF 2 slot 3 ch 2 DUMPF or All DUMPF

DUMPV -- The dumpv command dumps the voltage settings of the system channels to a file for downloading instrument setups. This command requires use of the slot command for selecting the required slot to be dumped, or use of the all command to dump the format of the instrument. This command should be used in conjunction with the dumpf and dumpt commands, which allow you to download the format and rise/fall time setups. The mainframe, slot and channel must be accessed unless the ALL command is used.
ex... mf 3 slot 4 ch 4 dumpf or all dumpv

DUMPT -- The dumpt command dumps the format of the system channels to a file for downloading instrument setups. This command requires use of the slot command for selecting the required slot to be dumped, or use of the all command to dump the format of the instument. This command should be used in conjunction with the dumpv and dumpf commands, which allow you to download the format and voltage setups. The mainframe, slot and channel must be accessed unless the ALL command is used.ex... mf 3 slot 4 ch 1 dumpt or all dumpt

DUMPLD -- This command allows you to dump the limit settings of the Driver PC Cards. This includes the High Rail (Upper Limits), the Low Rail (Lower Limits), and the Maximum Output Amplitude settings. This dump can be on an individual channel basis or all of the driver channels at one time. ex...

```
mf 1 slot 2 ch 2 DUMPLD
   or    ALL DUMPLD
```

DUMPLB -- This command allows you to dump the limit settings of the Bias PC Cards. This includes the Upper Voltage Limit (Upper Limit) and The lower Voltage Limit (Lower Limit). This command can be used to dump individual channels or all of the Bias channels at one time. ex...

```
MF 2 SLot 6 CH 1 DUMPLB
  or      ALL dumplb
```

UPDATEOFF -- Turns off the update function so that the data being loaded will not be updated to the CRT screen during the loading period. You must however, send the UPDATEON command at the end of the file to update the data on the CRT screen. See Section 9.2.4

UPDATEON -- Turns the update function back on when turned off by the UPDATEOFF command. See 9.3.13 Increasing Download Speed.

The default upon power-up is the UPDATEON command. These commands do not require the ALL command, since they are block commands that automatically affect the entire instrument.

ID -- Sending ID provides you with information on the PI-4001 IEEE-488 address, and driver or bias card locations.

The output buffer provides you with all the card information. You have not cleared the status buffer of all available messages until you receive an End Of File Marker (1A Hex).

The order of appearance of the ID message sequence is as follows:

- - PI-4001 5 (IEEE-488 address)
- - PI-4002
- - MF 1 slot 1 40460 Driver
- - MF 1 slot 2 40740 Bias
- - The End Of File Marker (1A Hex)

9.3.14 90040 NON-VOLATILE MEMORY OPTION COMMANDS

All of the functions of the 90040 Non-Volatile Memory Option are available over the IEEE-488 Bus and through the RS-232-C Port. The files can be loaded, saved, and deleted with these commands.

DIR -- Provides back to your controller, a directory of all files currently stored in the Non Volatile Memory. ex... DIR

LOAD num -- Allows loading a complete program as referenced by the number that was assigned when the program was originally saved. ex... LOAD 12

The following command is used to delete files from the 90070 Non-Volatile Memory Option. IF YOU USE THE DELETE COMMAND THE FILES REFERENCED WILL BE PERMANENTLY DESTROYED. ONCE THE COMMAND IS SENT, THE FILE IS LOST.

DELETE num -- Allows Deleting a complete program as referenced by the number that was assigned when the program was originally saved. ex... DELETE 12

SAVE num -- Allows saving a complete program currently in memory as referenced by the number you assign. ex... SAVE 3

PWRONFILE num -- Save the program currently in memory as the default program that is automatically loaded upon power up of the instrument. This saved default program will also include the voltage limits on the Driver and Bias PC Cards that are currently in the system. You can also convert any setup file currently in the Non-Volatile Memory to the Power on File by sending the command PWRONFILE and the number of the file you wish to be the new power on file. For example file 23 could be made the Power ON file with the command PWRONFILE 23. ex... PWRONFILE 23

9.3.15 Increasing Download Speed

When loading data over the IEEE-488 bus or through the RS-232-C port, with the Driver Format and Set Up Menu or Bias Set Up Menu displayed, the PI-4001 updates the CRT screen each time it receives a carriage return (CHR$(13)) and line feed (CHR$(10)).

Since many users write programs that consist of one line statements followed by a carriage return and line feed, the update process upon receipt of the carriage return and line feed can slow the loading process considerably.

There are three ways to avoid this slow down during load:

1. If the instrument is on the Interface Menu during load, the update process will not occur and there is no loss of speed. The

Main Menu will be automatically updated the next time it is accessed.

2. If the statements are sent to the PI-4001 as larger strings of data between carriage returns and line feeds you will also speed up the load process. You can combine the data into strings as large as 2048 bytes before a carriage return and line feed are required. Spaces are still required.

9.4 SAMPLE PROGRAM FOR IEEE-488 BUS

The following program was written for the IBM PC using the Ziatech IEEE-488 PC Card. The program will allow you to save and load files created for the 4000 Test System. A program similar to this for the National IEEE-488 PC Card is also available on disk from Pulse Instruments. Please consult the factory for details.

```
10 REM ******************************************************
20 REM *                                                    *
30 REM *     PULSE INSTRUMENT GPIB TEST PROGRAM             *
40 REM *      V1.0        6/16/1988                         *
50 REM *                                                    *
60 REM *     THIS PROGRAM WILL DEMONSTRATE HOW TO PROGRAM    *
70 REM *     PI-4000 LOW NOISE FOCAL PLANE ARRAY TEST SYSTEM *
80 REM *     GPIB WITH ZIATECH GPIB CONTROLLER (ZT 14444     *
90 REM *     OR ZT 1488A)                                   *
100 REM ******************************************************
110 REM
120 REM THIS IS FOR INITIALIZE THE COMPUTER MEMORY SIZE AND
130 REM ZIATECH GPIB CONTROLLER CARD
140 REM
150 REM DETERMINE COMPUTER MEMORY SIZE FIRST
160 REM
170 REM THIS ROUTINE WILL DETERMINE THE SYSTEM MEMORY SIZE
180 REM AND WILL LOAD THE SUBROUTINE IN A 64K OR LARGEER
190 REM SYSTEM
200 REM CLEAR SCREEN
210 CLS
220 REM ASSUME 64K SYSTEM
230 CLEAR ,&H7C00
240 REM
250 REM Get actual memory size from INT 12.
260 REM
270 DATA &H55,&H8B,&HEC,&H8B,&H5E,&H06,&HCD
275 DATA &H12,&H89,&H07,&H5D,&HCA,&H02,&H00
280 REM LOAD TEMPORATORY ROUTINE HERE
290 DEF SEG = &H500
300 REM REPEAT UNTIL ALL LOADED
310 FOR I% = 0 TO 13
320 READ J%
330 POKE I%,J%
340 NEXT
350 REM
360 REM INITIALIZE ALL THE ZIATECH CARD VARIABLES
370 REM
380 SUBRT% = 0
390 MEMSIZE% = 0
400 CALL SUBRT%(MEMSIZE%)
410 MEMSIZES$ = STR$(MEMSIZE%)
```

```
420 PRINT USING "&";"Memory size is",MEMSIZES$,"K-Bytes."
430 IF MEMSIZE% < 64 THEN PRINT "Non-sufficient memory":END
440 DEF SEG = &H2500
450 REM
460 REM Load ZT 1488 GPIB and clock routines.
470 REM
480 REM LOAD ZIATECH ZT 1488 ASSEMBLY LANGUAGE GPIB INTERFACE
490 REM
500 BLOAD "BIALL.m", 0
510 REM
520 REM GET ADDRESSES FOR ASSEMBLY LANGUAGE ROUTINES AND EQUATES
530 REM TO OFFSETS IN USER DEFINED SEGMENT.
540 REM
550 GETADR = PEEK(1)*256 + PEEK(0)
560 DIM SUB%(25)
570 FOR I% = 0 TO 24
580 CALL GETADR ( I%, SUB%(I%) )
590 NEXT I%
600 ERSTAT=SUB%(0)
610 INIT=SUB%(1)
620 SENDST=SUB%(2)
630 RECVST=SUB%(3)
640 SRQSTA=SUB%(4)
650 REMOTE=SUB%(5)
660 LOCL=SUB%(6)
670 LOKOUT=SUB%(7)
680 DEVCLR=SUB%(8)
690 TRIG=SUB%(9)
700 TERM=SUB%(10)
710 TIMEDY=SUB%(11)
720 PPOLL=SUB%(12)
730 PPOLLE=SUB%(13)
740 PPOLLU=SUB%(14)
750 PPOLLD=SUB%(15)
760 SPOLL=SUB%(16)
770 SETPRI=SUB%(17)
780 SETSEC=SUB%(18)
790 TEST=SUB%(19)
800 CMD = SUB%(20)
810 XFER = SUB%(21)
820 SENDDM = SUB%(22)
830 RECVDM = SUB%(23)
840 PROLEN = SUB%(24)
850 REM
860 REM GPIB names initialized
870 REM
880 REM load into def seg + prolen
890 REM get addr should be at offset prolen
900 DIM ADDR%(21)
910 GETADR = PROLEN      ' location of clock get address routine
920 FOR I% = 0 TO 12
```

```
930 CALL GETADR ( I%, ADDR%(I%) )
940 NEXT I%
950 REM
960 LODCLK = ADDR%(3)
970 LODLAT = ADDR%(4)
980 RDCLK = ADDR%(5)
990 RDLAT = ADDR%(6)
1000 TIME = ADDR%(7)
1010 SYNCH = ADDR%(8)
1020 SYSTIK = ADDR%(9)
1030 ALARM = ADDR%(10)
1040 INSTAT = ADDR%(11)
1050 REM
1060 REM BASIC NOW INITIALIZED, INITIALIZE COMMON VARIABLES
1070 REM
1080 REM Order of variables in common must agree with order
1090 REM       shown below.
1100 REM
1110 COMMON ERCODE%,RCVLEN%,BASECLK%,BASEPORT%,
     BASEPRI%,BASESEC%,YEAR%
1120 BASECLK% = &H240            ' initialize common
1130 BASEPORT% = &H210
1140 BASEPRI% = &H210
1150 BASESEC% = &H220
1160 YEAR% = &H3838              ' ascii code for 88
1170 REM
1180 REM ON WITH THE USER PROGRAM
1190 REM
1200 DELAY%=3000:CALL TIMEDY(DELAY%)
1210 CALL INIT
1220 REM
1230 REM ******************************************************
1240 REM *                                                    *
1250 REM *  THIS IS A SAMPLE PROGRAM WHICH WILL DEMONSTRATE   *
1260 REM *  HOW TO PROGRAM THE PULSE INSTRUMENTS              *
1270 REM *  PI-4000 LOW NOISE FOCAL PLANE ARRAY TEST SYSTEM   *
1280 REM *                                                    *
1290 REM ******************************************************
1300 REM
1310 REM LINE FEED
1320 REM
1330 LF$ = CHR$(&HA)
1340 REM
1350 REM SET GPIB CONTROLLER TERMINATE AT LINE FEED
1360 REM
1370 CALL TERM(LF$)
1380 REM
1390 REM SET PULSE INSTRUMENT PI-4000 GPIB ADDRESS 7
1400 REM
1410 DEVNO$="7"+" "
1420 REM
```

```
1430 REM THE FOLLOWING FEW LINES DEFINE DRIVER CARD
1440 REM
1450 REM 40460 DRIVER CARD LOCATES MAINFRAME 1 SLOT 1
1460 REM PROGRAM CHANNEL 1 HIGH LEVEL VOLTAGE 10
1470 REM                   LOW LEVEL VOLTAGE -10
1480 REM                   RISE TIME 50 NS
1490 REM                   FALL TIME 60 NS
1500 REM PROGRAM CHANNEL 2 HIGH LEVEL VOLTAGE 5
1510 REM                   LOW LEVEL VOLTAGE -5
1520 REM                   RISE TIME 500 NS
1530 REM                   FALL TIME 600 NS
1540 REM
1560 SENDST$ = "MF 1 SLOT 1 CH 1 HLV 10 LLV -10 TR 50 TF 60"
1570 GOSUB 3500
1580 SENDST$ = "MF 1 SLOT 1 CH 2 HLV 5 LLV -5 TR 500 TF 600"
1590 GOSUB 3500
1600 REM
1610 REM
1620 REM THE FOLLOWING FEW LINES DEFINE BIAS SUPPLY CARD
1630 REM
1640 REM 40740 BIAS SUPPLY CARD LOCATES MAINFRAME 2 SLOT 1
1650 REM CHANNEL 1 PROGRAM 10 VOLT 10mA/V CURRENT SENSE
1660 REM CHANNEL 2 PROGRAM -5 VOLT 1mA/V CURRENT SENSE
1670 REM CHANNEL 3 PROGRAM 5 VOLT AT 0.5 mV RESOLUTION
1680 REM CHANNEL 4 CAN NOT BE PROGRAMMED BECAUSE CHANNEL 3
1690 REM  IS IN HIGH RESOLUTION MODE
1700 REM
1710 SENDST$ = "MF 2 SLOT 1 CH 1 VOLT 10 ISENSE2"
1720 GOSUB 3500
1730 SENDST$ = "MF 2 SLOT 1 CH 2 VOLT -5 ISENSE1"
1740 GOSUB 3500
1750 SENDST$ = "MF 2 SLOT 1 CH 3 VOLT 5 HR"
1760 GOSUB 3500
1770 REM
1780 REM
1790 REM THE FOLLOWING FEW LINES DEFINE
1800 REM LOW NOISE BIAS SUPPLY CARD
1810 REM
1820 REM 40750 LOW NOISE BIAS SUPPLY CARD
1830 REM LOCATES MAINFRAME 2 SLOT 2
1840 REM CHANNEL 1 PROGRAM -10 VOLT 10mA/V CURRENT SENSE
1850 REM CHANNEL 2 PROGRAM 5 VOLT 1mA/V CURRENT SENSE
1860 REM CHANNEL 3 PROGRAM -5 VOLT AT 0.5 mV RESOLUTION
1870 REM CHANNEL 4 CAN NOT BE PROGRAMMED BECAUSE CHANNEL 3
1880 REM            IS IN HIGH RESOLUTION MODE
1890 REM AND SET THE SLOT 2 ALL FOUR CHANNELS
1900 REM AT LOW RANGE (LRANGE) OPERATED AT +10.235 TO -10.24 VOLT
1910 REM AND RESOLUTION WILL BE 5 mV & .25mV
1920 REM AND LOW NOISE MODE
1930 REM
1940 SENDST$ = "MF 2 SLOT 2 CH 1 VOLT -10 LRANGE ISENSE2"
```

```
1950 GOSUB 3500
1960 SENDST$ = "MF 2 SLOT 2 CH 2 VOLT 5 ISENSE1"
1970 GOSUB 3500
1980 SENDST$ = "MF 2 SLOT 2 CH 3 VOLT -5 HR LNOISE"
1990 GOSUB 3500
2000 REM
2010 REM THE NEXT LINE MAKE THE CHANGES ONLINE
2020 REM
2030 SENDST$ = "ONLINE" : GOSUB 3500
2040 REM
2050 REM NEXT FEW LINES WILL DEMONSTRATE HOW TO UPLOAD THE
2060 REM MESSAGES FROM THE INSTRUMENTS TO COMPUTER
2070 REM
2080 REM SENDS - STATUS - TO INSTRUMENT
2090 REM
2100 SENDST$ = "STATUS" : GOSUB 3500
2110 REM
2120 REM INSTRUMENT WILL REPSPOND FOUR LINE MESSAGES BACK
2130 REM SUCH AS : STOP (OR RUN) <CR> <LF>
2140 REM            ERROR 0 <CR> <LF>
2150 REM            NO ERROR  <CR> <LF>
2160 REM            1A <CR> <LF> AND EOI
2170 REM
2180 GOSUB 4000 : PRINT RECVST$
2190 GOSUB 4000 : PRINT RECVST$
2200 GOSUB 4000 : PRINT RECVST$
2210 GOSUB 4000 : PRINT RECVST$
2220 REM
2230 REM NEXT FEW LINES WILL DEMONSTRATE HOW TO UPLOAD THE
2240 REM MESSAGES FROM THE INSTRUMENTS TO COMPUTER
2250 REM
2260 REM SENDS -  ALL DUMPV  - TO INSTRUMENT
2270 REM
2280 REM UPLOAD ALL THE VOLTAGE SETTING AT DRIVER & BIAS CARD
2290 REM
2300 SENDST$ = "ALL DUMPV" : GOSUB 3500
2310 REM
2320 REM INSTRUMENT WILL REPSPOND MESSAGES BACK
2330 REM IF DRIVER CARD LOCATES AT MAINFRAME 1 SLOT 1
2340 REM AND BIAS SUPPLY CARD LOCATES AT MAINFRAME 2 SLOT 1
2350 REM AND LOW NOISE BIAS SUPPLY CARD LOCATES AT MAINFRAME
2360 REM 2 SLOT 2
2370 REM          MESSAGE WILL BE :
2380 REM                MF 1 SLOT 1 CH 1 HLV 10 LLV -10 <CR> <LF>
2390 REM                MF 1 SLOT 1 CH 2 HLV 5 LLV -5 <CR> <LF>
2400 REM                MF 2 SLOT 1 CH 1 VOLT 10
2410 REM                MF 2 SLOT 1 CH 2 VOLT -5
2420 REM                MF 2 SLOT 1 CH 3 VOLT 5
2430 REM                MF 2 SLOT 2 CH 4 VOLT 0
2440 REM                MF 2 SLOT 1 CH 1 VOLT -10
2450 REM                MF 2 SLOT 1 CH 2 VOLT 5
```

```
2460 REM                MF 2 SLOT 1 CH 3 VOLT -5
2470 REM                MF 2 SLOT 2 CH 4 VOLT 0
2480 REM                1A <CR> <LF> AND EOI
2490 REM
2500 GOSUB 4000 : PRINT RECVST$
2510 GOSUB 4000 : PRINT RECVST$
2520 GOSUB 4000 : PRINT RECVST$
2530 GOSUB 4000 : PRINT RECVST$
2540 GOSUB 4000 : PRINT RECVST$
2550 GOSUB 4000 : PRINT RECVST$
2560 GOSUB 4000 : PRINT RECVST$
2570 GOSUB 4000 : PRINT RECVST$
2580 GOSUB 4000 : PRINT RECVST$
2590 GOSUB 4000 : PRINT RECVST$
2600 GOSUB 4000 : PRINT RECVST$
2610 REM
2620 REM SENDS -  ALL DUMPT  - TO INSTRUMENT
2630 REM
2640 REM UPLOAD ALL THE RISE & FALL TIME SETTING AT DRIVER CARD
2650 REM
2660 SENDST$ = "ALL DUMPT" : GOSUB 3500
2670 REM
2680 REM INSTRUMENT WILL REPSPOND MESSAGES BACK
2690 REM          IF DRIVER CARD LOCATES AT MAINFRAME 1 SLOT 1
2700 REM          MESSAGE WILL BE :
2710 REM    MF 1 SLOT 1 CH 1 RANGE1 TR 50 TF 60 <CR> <LF>
2720 REM    MF 1 SLOT 1 CH 2 RANGE2 TR 500 TF 600 <CR> <LF>
2730 REM    1A <CR> <LF> AND EOI
2740 REM
2750 GOSUB 4000 : PRINT RECVST$
2760 GOSUB 4000 : PRINT RECVST$
2770 GOSUB 4000 : PRINT RECVST$
2780 REM
2790 REM SENDS -  ALL DUMPF  - TO INSTRUMENT
2800 REM
2810 REM UPLOAD ALL THE FORMAT SETTING AT DRIVER & BIAS CARD
2820 REM
2830 SENDST$ = "ALL DUMPF" : GOSUB 3500
2840 REM
2850 REM INSTRUMENT WILL REPSPOND MESSAGES BACK
2860 REM IF DRIVER CARD LOCATES AT MAINFRAME 1 SLOT 1
2870 REM ,BIAS SUPPLY CARD LOCATES AT MAINFRAME 2 SLOT 1
2880 REM MESSAGE WILL BE :
2890 REM      MF 1 SLOT 1 CH 1 NONINV VSENSE2 <CR> <LF>
2900 REM      MF 1 SLOT 1 CH 2 NONINV VSENSE2 <CR> <LF>
2910 REM      MF 2 SLOT 1 CH 1 LR ISENSE2
2920 REM      MF 2 SLOT 1 CH 2 LR ISENSE1
2930 REM      MF 2 SLOT 1 CH 3 HR VSENSE2
2940 REM      MF 2 SLOT 2 CH 4 HR VSENSE2
2950 REM      MF 2 SLOT 1 CH 1 LR ISENSE2 REGULAR LRANGE
2960 REM      MF 2 SLOT 1 CH 2 LR ISENSE1 REGULAR LRANGE
```

```
2970 REM      MF 2 SLOT 1 CH 3 HR VSENSE2 LNOISE LRANGE
2980 REM      MF 2 SLOT 2 CH 4 HR VSENSE2 REGULAR LRANGE
2990 REM                 1A <CR> <LF> AND EOI
3000 REM
3010 GOSUB 4000 : PRINT RECVST$
3020 GOSUB 4000 : PRINT RECVST$
3030 GOSUB 4000 : PRINT RECVST$
3040 GOSUB 4000 : PRINT RECVST$
3050 GOSUB 4000 : PRINT RECVST$
3060 GOSUB 4000 : PRINT RECVST$
3070 GOSUB 4000 : PRINT RECVST$
3080 GOSUB 4000 : PRINT RECVST$
3090 GOSUB 4000 : PRINT RECVST$
3100 GOSUB 4000 : PRINT RECVST$
3110 GOSUB 4000 : PRINT RECVST$
3500 REM
3510 REM OUTPUT A STRING FROM COMPUTER TO PI-4000
3520 REM
3530 REM
3540 REM CONCATENATE THE SENDST STRING WITH <CR> AND <LF>
3550 REM
3560 SENDST$=SENDST$+CHR$(13)+CHR$(10)
3570 REM
3580 REM CALL ZIATECH SEND STRING FUNCTION
3590 REM
3600 CALL SENDST (DEVNO$,SENDST$)
3610 RETURN
4000 REM
4010 REM INPUT A STRING FROM PI-4000 TO THE COMPUTER
4020 REM
4030 REM EMPTY THE RECEIVE STRING
4040 ALLOCATE%=255 : EOL$=CHR$(13)+CHR$(10)
4050 RECVST$=SPACE$(ALLOCATE%)
4060 REM
4070 REM CALL ZIATECH RECEIVE STRING FUNCTION
4080 REM
4090 CALL RECVST (DEVNO$,RECVST$)
4100 POINTER = INSTR(RECVST$,EOL$)
4110 IF POINTER > 0 THEN RECVST$=LEFT$(RECVST$,POINTER-1)
4120 RETURN
5000 REM
5010 REM SAVE THE DATA FROM PI-4000 TO FILE
5020 REM FILE NAME : USER DEFINED
5030 REM
5040 REM OPEN FILE AS OUTPUT
5050 REM
5060 OPEN "O",1,FILE$
5070 REM
5080 REM RECEIVE STRING FROM PI-4000
5090 REM CALL ZIATECH CARD RECVST FUNCTION
5100 REM
```

```
5110 GOSUB 4000
5120 REM
5130 REM COMPARE WITH THE END OF FILE MARKER 1A HEX
5140 REM OR YOU CAN SETUP YOUR GPIB CONTROLLER TERMINATED
5150 REM BY EOI IN ZIATECH CARD IS TERM("@") THEN YOUR
5160 REM CONTROLLER WILL RECEIVED THE WHOLE FILE BACK UNTIL
5170 REM EOI
5180 REM
5190 IF LEFT$(RECVST$, 1) = CHR$(&H1A) THEN 5240
5200 REM
5210 REM SAVE THE STRING INTO THE FILE JUST CREATED
5220 REM
5230 PRINT #1,RECVST$ : GOTO 5070
5240 REM
5250 REM THEN CLOSE THE FILE
5260 REM
5270 CLOSE #1
5280 RETURN
6000 REM
6010 REM DUMP DATA FROM FILE TO PI-4000
6020 REM FILE NAME : USER DEFINED
6030 REM
6040 REM OPEN FILE AS INPUT
6050 REM
6060 OPEN "I",1,FILE$
6070 REM
6080 REM IS IT END OF FILE ?
6090 REM
6100 IF EOF(1) THEN 6190
6110 REM
6120 REM GET DATA STRING THEN SEND IT ACROSS THE GPIB BUS
6130 REM
6140 INPUT #1,SENDST$
6150 REM
6160 REM CALL ZIATECH CARD SENDST FUNCTION
6170 REM
6180 GOSUB 3500 : GOTO 6100
6190 REM
6200 REM THAT'S ALL, CLOSE THE FILE
6210 REM
6220 CLOSE #1 : RETURN
```

10.0 RS-232-C PROGRAMMING

10.1 General

The PI-4001 Control Mainframe is compatible with the EIA STD. RS-232-C standard for full duplex asynchronous receiver/transmitter operation when connected to a controller employing serial binary data interchange.

The information regarding use of this standard is given below. However, we suggest that you refer to the manual on your controller for implementation instructions and information before proceeding.

The commands that are available for use with the RS-232-C standard are identical to all commands that can be used over the IEEE-488 bus.

10.2 RS-232-C PINOUTS

The pins on the RS-232-C connector required for this function are as follows:

Pin 1 - Ground - Case or Shield.
Pin 2 - Receive Data (xmit data connection on controller).
Pin 3 - Transmit Data (receive data connection on controller).
Pin 4 - RTS (Request To Send) input.
Pin 5 - CTS (Clear To Send) output.
Pin 6 - DSR (Data Set Ready) input.
Pin 7 - Ground - Signal.
Pin 20 - DTR (Data Terminal Ready) output.

10.3 PROGRAMMING INFORMATION - RS-232-C

The parameter set-up for the RS-232-C is located on the Interface menu. The softkeys are used to toggle through the available settings until the needed parameters are selected.

The default settings upon power up are:

1200 - Baud Rate
NONE - Parity Rate
8 - Data Rate
1 - Stop Bit

These settings can be changed by pressing the [MORE] softkey to display the second page of softkeys on the Interface Menu, and toggling the appropriate softkeys until the appropriate parameter settings are obtained.

Once you have set up the required RS-232-C parameters and have finished all other programming functions that you require prior to operating the PI-4001 over the RS-232-C link, press the [NEXT] Key and return the Control Mainframe to the Interface Menu display.

All commands that are used on the PI-4001 to operate the instrument over the IEEE-488 Bus are identical to the command requirements through the RS-232-C Port.

NOTE: If the baud rate is set for operation at higher than 2400 bps, the device communications buffer in your controller must be set for more than 1K bytes. For example, when using IBM PC/XT Basic, the command:

```
Basic /C: 1024
```

will set the buffer for 1024 bytes.

The next page contains a sample program for inputting commands from the terminal.

10.4 SAMPLE RS-232-C PROGRAM

Below is a sample program written in BASIC for the IBM PC that demonstrates the programming structure:

```
100 CLS
110 REM      PULSE INSTRUMENTS RS-232-C SAMPLE PROGRAM
120 REM
130 REM use F10 key instead of return key, because it adds a line
      feed
140     KEY OFF : KEY 10 , CHR$(13) + CHR$(10)
150 REM
160 REM set up serial port to 4001 default value
170 REM baud = 1200, no parity, 8 data bits, 1 stop bit and
     control dsr
180     OPEN "com1 : 1200,n,8,1,ds" AS #1
190 REM
200 REM
210 REM  This reads the keyboard, and sends out what ever you
         type
220 REM
230     B$=INKEY$ : IF B$=CHR$(6) THEN RETURN ELSE IF B$<>"" THEN
        PRINT B$;:PRINT#1,B$;
240     IF EOF(1) THEN 230
250 REM
260 REM  this reads the serial port for input and prints data on
         the screen
270 REM
280      A$ = INPUT$(LOC(1),#1)
290      PRINT A$;
300      GOTO 230
```

11.0 EPROM REPLACEMENT IN THE PI-4001 CONTROL MAINFRAME

Installing Version 3.X EPROMS and Video Character ROMS in the PI-4001 Control Mainframe

The following procedure explains EPROM replacement in the PI-4001 Control Mainframe. Please note that software improvements will rarely affect your computer program. In the event that a change does affect your program, you will receive detailed information on the modification and where it will affect your program. If you did not receive these instructions, then the version of software that you have received will not effect your programs.

NOTE: IF YOUR INSTRUMENT CONTAINS NON-VOLATILE MEMORY, IT MUST BE DUMPED AND SAVED, SINCE INSTALLATION OF VERSION 3.00 SOFTWARE (AND ABOVE), WILL DESTROY THE CONTENTS OF THE NON-VOLATILE MEMORY WHEN FIRST POWERED UP.. SEE BELOW RE-INITIALIZING NON-VOLATILE MEMORY.

1. Remove the 6 screws in the top cover and lift off top cover.

2. The CPU Board that contains the EPROMS is the board directly in front of the fan with the identification markings 55000684 80186 CPU or 55000685 B 80186 CPU. Gently remove the card from it's connector.

3. With the board on the bench, component side up, position the board so that the connector pin side is closest to you. The EPROMS at the top right hand side of the board are the devices to be changed.

4. REMOVE ALL FOUR EPROMS AND PLACE THE TWO EPROMS THAT YOU HAVE RECEIVED IN THE TOP TWO SOCKETS. THE NEW EPROM LABELED 4000B WILL BE PLACED IN THE TOP SOCKET, AND THE NEW EPROM LABELED 4000A WILL BE PLACED IN THE SOCKET DIRECTLY BELOW THE TOP SOCKET. THE INDENTATION IN THE EPROM SHOULD BE TO THE LEFT WHEN THE PC BOARD IS IN THE CORRECT POSITION WITH THE PINS ON THE PC BOARD DIRECTLY IN FRONT OF YOU.

5. Verify that all devices are installed in their proper sockets, all pins are seated properly, and that all are firmly pressed down.

6. Re-insert the CPU Board, turn on power and verify proper operation of the unit. If your system contains non-volatile memory, see the information below on re-initializing the non volatile memory.

7. Turn off Power. Install the board retaining screws on the rear of the CPU Board.

8. Install top cover, if character ROMS are not to be installed at this time. If character ROMS are to be installed, continue with the next section.

RE-INITIALIZING NON-VOLATILE MEMORY

1. If your system contains Non-Volatile Memory, the first time you turn on system power you will be presented with the message, "INITIALIZE ALL NON VOLATILE MEMORY" ENT = YES CE = NO.

2. If you press [ENT] the Non-Volatile Memory is Cleared, and you are presented with the message,"Enter Security Code". Upon receipt of this message, Enter the following four characters with the data keys: (XX)

3. The Non-Volatile Memory is now ready to use and future EPROM changes will not require this exercise, since this revision of software is the first use of a new operating system for the instrument.

INSTALLING THE CHARACTER ROMS

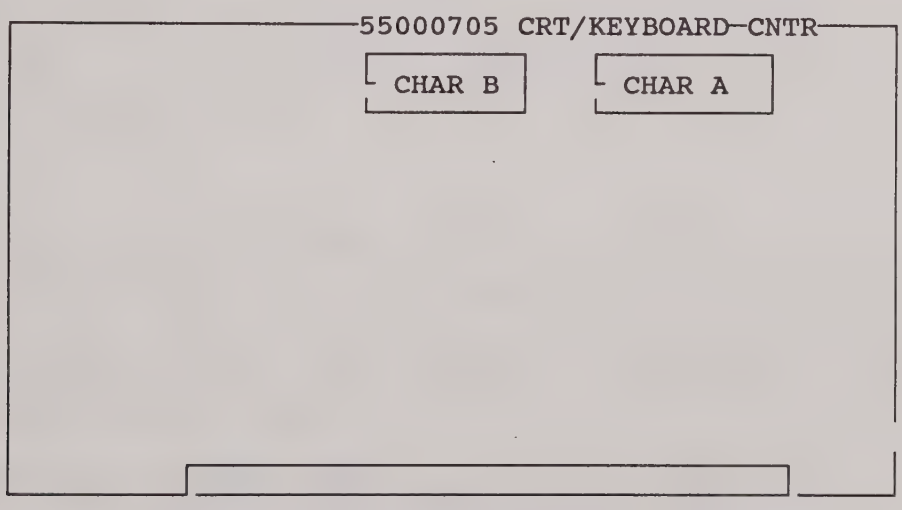

Figure 1 55000705 CRT/Keyboard Controller

1. Locate the CRT/Keyboard Controller PC Card Directly behind the CRT.

2. Gently remove the PC Card and place on Bench.

3. Remove the two ROMS from the sockets as shown in Figure 1.

4. Install the two ROMS marked Char A and Char B as shown above.

5. Turn on power, and verify operation of the instrument.

12.0 ERROR AND WARNING MESSAGES

12.1 GENERAL

Below is a list of the 4000 System's error messages and warnings. When an error occurs, or a warning is necessary, the message will be displayed on the menu you are presently using. The error message is removed by pressing any key except [ENT].

In the program mode, the errors and warnings are transmitted to the controller in the form of the numbers associated with the error messages specified in the section 12.2 below. Sending STATUS over the bus will return the code corresponding to the messages listed below. All errors must be cleared in this manner before proceeding. THE PI-4001 WILL NOT ACCEPT DATA OVER THE BUS IF THERE IS AN ERROR PENDING. See STATUS command in programming section 9.3.3 System Commands.

12.2 EXPLANATION OF ERROR AND WARNING MESSAGES

12.2.1 ERROR MESSAGES

An error message is a message that can be read from the status buffer on the Interface Menu, under program control. When in Remote Mode, the error message numbers below are displayed on the status line, on the Interface Menu. See section 9.3.3 System Commands, STATUS Command.

0. NO ERROR --

1. OUT OF RANGE --An attempt was made to enter a voltage greater than +20.47 or less than -20.48. The Out of Range Error also applies to an attempt to enter an incorrect programmable tr/tf.

2. DIFFERENCE IS MORE THAN ALLOWED -- An attempt was made to enter a driver high and low level voltage that exceeded the maximum allowable 25 volts.

4. UNABLE TO PROTECT TR/TF -- In some instances the Voltage settings may be too high to protect the rise and fall time.

6. CANNOT USE CONTROL CHANNEL -- An attempt was made to use an even numbered bias supply channel that is currently controlling the odd channel above it, in the High Resolution Mode.

7. MAINFRAME, SLOT OR CHANNEL NOT SELECTED -- An attempt was made to enter a command without identifying the location of the PC Card. See section 9.2.1.

8. FUNCTION NOT FOUND -- An attempt was made to access a function that does not exist.

9. SYNTAX ERROR -- Command structure is incorrect. See section 9.1.1 for information on structuring commands. Carriage Returns and Line Feeds are required.

10. WRONG CARD -- An attempt was made to perform a function that does not exist on the card that was accessed.

11. TIME OUT -- RS-232-C handshaking is incorrect, and The PI-4001 has expended the allotted time required to recognize the controller.

12. OVERRUN ERROR -- The data in the receiver buffer register was not read by the CPU before the next character was sent, thereby destroying the previous character.

13. PARITY ERROR -- The Parity set up is incorrect between the controller and the PI-4001. The parity set up in the PI-4001 must match the parity setup of the computer that is transmitting (or receiving).

14. FRAMING ERROR -- Indicates that the received character did not have a valid stop bit. There is not a match between the stop bit set up of the controller and the PI-4001.

15. CAN ONLY LABEL CHANNEL UP TO FOUR CHARACTERS -- An attempt was made to label a channel with more or less than four ASCII characters, the maximum allowed. Remember to add a space between the LABEL command and the four character Label, for CRT formatting.

16. DUPLICATED LABEL --An attempt was made to establish a Label name that is already being used.

17. SELECTED FILE DOES NOT EXIST -- An attempt was made to load a file from the Non-Volatile Memory Option that does not exist. Check file names with the DIR Command.

19. NO ROOM IN NON-VOLATILE MEMORY -- The maximum storage capacity of the Non-Volatile Memory Option is 256k Bytes.

20. NON-VOLATILE MEMORY CHECKSUM ERROR -- There was an error in saving or loading the program just loaded or saved to Non-Volatile Memory. Try the function again.

21. NON VOLATILE MEMORY OPTION DOES NOT EXIST -- An attempt was made to use a command that is reserved for use with the Non-Volatile Memory Option, and that option does not exist in the instrument you are using.

22. FILE NOT SAVED - SETTINGS OUT OF LIMITS -- An attempt was made to save a file into Non-Volatile Memory that contained either Driver or Bias Voltage output settings that are out of the range of the Programmed Limits that are established with this program. The system cannot accept these settings. Either change the limits or change the output voltages to conform with the limits that are set.

23. TR AND TF SET TO THE SAME RANGE -- This is a warning that the values set for the Rise and Fall Time on the selected channel must be on the same range.

24. UNABLE TO PROTECT TR/TF -- When voltages are changed the driver may be unable to maintain the slope because it is out of range of the slew rate of the driver. This message is also displayed when rise and fall time settings are in different ranges.

25. ALL SET -- After each Set All command, you will receive this message back (only on the CRT display).

26. WRONG NUMBER FORMAT -- Incorrect characters were used to enter numbers or expected parameters. ie... letters instead of numerals, two decimal points, negative signs in front of numbers that should not be negative.

27. PARAMETER EXPECTED -- A command has been received that also requires a number value or other parameter and the expected parameter was not included. Such as, sending the Volts command without following with the value or numerical portion of the command.

28. RS-232-C ERROR -- Overrun or frame error. May also happen when you initialize your computer. Generally a problem in the set up.

29. GPIB ERROR -- This is generally a problem with the set up.

30. INPUT BUFFER OVERFLOW -- When your command line is longer than the length of the buffer. ie.. the command line is greater than 6000 characters.

31. OUTPUT BUFFER OVERFLOW -- If you receive this error there is a problem in your system hardware. Please contact the manufacturer.

32. WRONG MAINFRAME, SLOT OR CHANNEL NUMBER -- An attempt was made to access a mainframe, slot, or channel, that the system does not recognize as existing. See section 9.2.1 General. Check that mainframe number is set properly.

35. LABEL NOT FOUND -- An attempt was made to use a label that has not been previously established, or an incorrect spelling of an established label was sent.

37. CONFIGURATION CHANGED -- A warning message that informs you that the PC Card locations in the file loaded from Non-Volatile Memory differs from the present hardware configuration of the system.

38. UNITS MISSING -- No time indication provided after a time reference number. ie... ns, ms, us.

40. FUNCTION NOT ALLOWED -- An attempt was made to use a function or command for the wrong device, ie sending a driver command to a bias PC Card, or sending a command to a PC Card while the PC Card is currently set up in a mode that will not allow action or acceptance of the command. May be also displayed when you turn off a device and the computer does not know that the device is turned off.

41. NON-VOLATILE MEMORY DIRECTORY FULL -- The maximum number of programs that can be stored in the Non-Volatile Memory is 64.

42. SCREEN OVERFLOW ERROR -- This error is created by a failure in the hardware portion of your system. Please report this error to the manufacturer.

43. IMPROPER STATUS CHANGE -- to change status from Disconnect to Online directly without going through Offline.

12.2.2 WARNING MESSAGES

A warning message is a message that is displayed on the CRT when you are not under program or remote control. Pressing any key except [ENT] will remove the error message.

OUT OF RANGE -- An attempt was made to enter a voltage greater than +20.47 or less than -20.48, which is the system default, or a Voltage greater than the limits that have been set. The Out of Range Error also applies to an attempt to enter an incorrect programmable tr/tf.

DIFFERENCE IS MORE THAN ALLOWED -- An attempt was made to enter a driver high and low level voltage that exceeded the maximum allowable for the selected PC Card.

EVEN CHANNEL HAS CONTROL, CHANNEL DATA WILL BE LOST -- This warning message is displayed during setup of the High Resolution function, to warn you that entering the High Resolution Mode will remove from use the even channel below the channel that you are attempting to set in High Resolution Mode.

SELECT RANGE 1 FOR 2ns/V OR RANGE 2 FOR 20ns/V <ENTER 1 OR 2> -- This message informs you that you are nearing the end of the programmable tr/tf range that you have selected on the Driver Status and Setup Menu, and you will have to make a decision to stay on the range that you are using, or go to a higher range that will allow less adjustment resolution.

SELECT RANGE 2 FOR 20NS/V OR RANGE 3 for 200ns/V <ENTER 2 OR 3> -- This message informs you that you are nearing the end of the programmable tr/tf range that you have selected, and you will have to make a decision to stay on the range that you are using, or go to a higher range that will allow less adjustment resolution.

CONTROL CHANNEL CANNOT BE USED -- An attempt was made to use an even numbered bias supply channel that is currently controlling the odd channel above it, in the High Resolution Mode.